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CONTENTS.

	PAGE
On the Treatment and Utilization of Anthropological Data.—V. Cranial Form. By Arthur Thomson, M.A., M.B. (*Illustrated*)	217
Sir Michael Foster's Presidential Address to the British Association, September 13th, 1899 ...	219
Two Months on the Guadalquiver.—IV. Scrub and Wood. By Harry F. Witherby, F.Z.S., M.B.O.U. ...	222
The Karkinokosm, or World of Crustacea.—XI. Taste and Try. By the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S., F.Z.S. (*Illustrated.*) (*Plate*)	224
Letters: David Flanery (*Illustrated*); Gavin J. Burns, B.Sc.; T. W. Backhouse; Baron N. Kaulbars; C. Crouch	226
Obituary	228
Science Notes	228
British Ornithological Notes. Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.	229
Notices of Books	229
Books Received	230
Ben Nevis and its Observatory.—II. By William S. Bruce, F.R.S.G.S. (*Illustrated*)	231
Some Suspected Variable Stars.—III. By J. E. Gore, F.R.A.S.	233
Secrets of the Earth's Crust.—V. The Great Earth-Mill. By Grenville A. J. Cole, M.R.I.A., F.G.S. (*Illustrated*)	235
Notes on Comets and Meteors. By W. F. Denning, F.R.A.S.	237
Microscopy. By John H. Cooke, F.L.S., F.G.S. (*Illustrated*)	238
The Face of the Sky for October. By A. Fowler, F.R.A.S.	239
Chess Column. By C. D. Locock, B.A.	239

ON THE TREATMENT AND UTILIZATION OF ANTHROPOLOGICAL DATA.

By Arthur Thomson, M.A., M.B.

V.—CRANIAL FORM.

HITHERTO we have confined our remarks to questions relating to colour, hair, proportions and height. We must now direct our attention to the consideration of the head. For various reasons this is the part of the human frame which has been most thoroughly studied, though it must be admitted that the vast amount of labour which has been expended on its minute and careful examination has not hitherto been productive of commensurate results.

The form of the head and the type of features naturally commend themselves to us in our attempts to analyse racial characteristics, for they are the parts of the body most exposed to our observation, and though it is a matter of great difficulty to secure all the bones of a skeleton, especially if a considerable time has elapsed since the interment of the individual, there is not much trouble involved in picking up a skull. Consequently, whilst the material at our disposal, so far as it relates to the complete skeleton, is meagre, there is no lack of skulls wherefrom to draw conclusions. It is beyond the scope of these articles to enter into all the detail and minutiæ with which the expert alone can be expected to be conversant, it is rather our intention to point out the features which appear to be of value in enabling us to determine with some approach to accuracy those distinctions in structure and form which may be considered racial characteristics.

The skeleton of the head, called the skull, includes those bones which form the protective covering for the brain and those which support and surround the various structures lodged within the cavities of the face. The only movable bone of the skull is the lower jaw; for this reason it is apt to become separated from the other bones and, in consequence, lost. To a skull from which the lower jaw is absent we apply the term cranium. Owing to the fact that the remaining bones of the face are apt to be destroyed in the process of decay, we often meet with specimens in which they are broken away; in this case the bony envelope of the brain, which is called the calvaria, alone remains. Stress must be laid on these details, as when in cataloguing skulls we make use of the terms skull, cranium, and calvaria, we imply thereby certain definite structures.

The appearance of the head in the living depends upon the relative proportions and forms of the calvaria and the bones of the face; it will be necessary therefore to refer to these in detail. The size of the calvaria is subject to great variation, both as regards capacity and form. As it is this part of the skull that contains the brain, an organ which in man attains its highest proportionate development, it will be obvious that the size of the calvaria must be correlated with the amount of brain substance contained within it, for, generally speaking, the osseous case is closely moulded round the great central nervous mass, so that its contours correspond roughly to the form of the encephalon. The exceptions to this rule will be especially referred to hereafter. But whilst no doubt the size of the calvaria is largely dependent on the development of the brain, it must be pointed out that its shape is to some extent controlled by its association with the lower jaw. This depends on the fact that one of the most powerful muscles which moves the lower jaw—*i.e.*, the temporal muscle—arises from the side of the skull, and according to its size and the extent of its attachment leads to variations in the form of the calvaria which are quite characteristic.

As will be readily understood from what has been said, it is a matter of no great difficulty to estimate approximately the size of the brain from the examination of a calvaria; if the capacity of the cranial cavity be gauged it will conform generally with the amount of nervous matter lodged within it during life. The cranial capacity may be measured in a variety of ways, but before doing so it is necessary to prepare the skull for this method of examination. Bones which have for centuries lain in their places of burial are apt to become exceedingly brittle owing to the disappearance of the organic matter which binds together the earthy salts. Such specimens are liable to crumble away when handled, and means must be taken to preserve them from further disintegration. Of these, none is better than that of making a warm solution of thin size into which the bones are placed and retained for some time. After being taken out of the fluid they are allowed to drain, and after being dried will be found to have lost all their brittle qualities, and can be now freely handled and measured.

A further precaution necessary before proceeding to take the cranial capacity is to block up the various clefts and

XUM

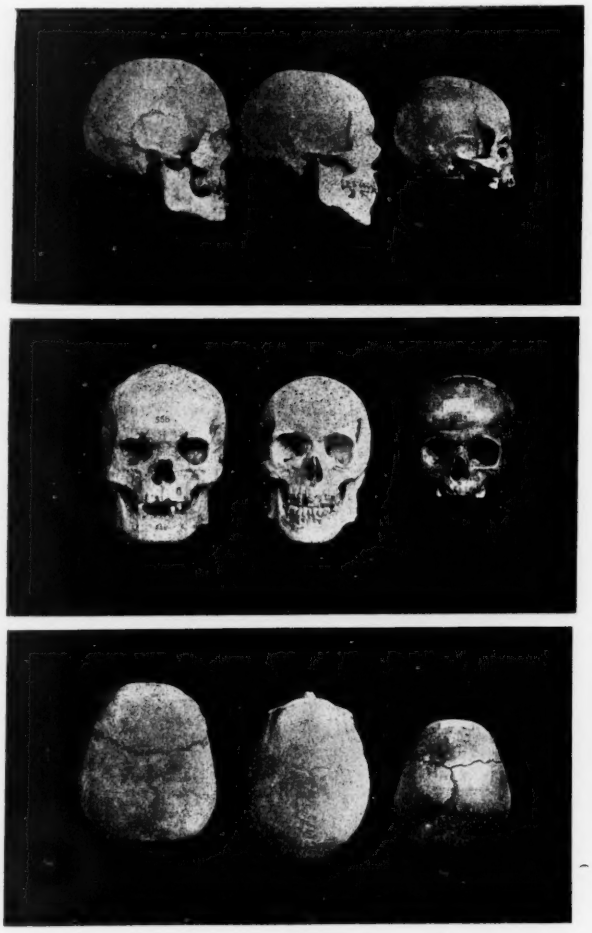
holes which open into the interior; cotton wool or modelling clay may be used for this purpose.

A variety of methods have been adopted to determine the cranial capacity. They all have certain advantages and disadvantages. The ideal method, of course, would be to fill the interior of the calvaria with fluid introduced through the foramen magnum, and then measure the amount of liquid contained; but this is open to grave objection on account of the difficulty of making the skull water-tight. Of recent years, an ingenious way of overcoming this difficulty has been introduced. A fine bladder is introduced into the inside of the calvaria, and into this the fluid is poured. We are unable, however, to speak from experience as to whether this arrangement is satisfactory or no. Of other plans adopted, the most common are those in which small shot (No. 8 for preference), small glass beads, or fine seeds of various kinds are used. Simple though it appears to measure skulls in this way, by pouring in shot and then pouring it out again, and taking its cubage, it requires very considerable experience before any degree of accuracy can be attained. The utmost care must be taken to use the same measures and funnels into which and through which the shot is poured. The height from which the shot is poured must always be the same, and precisely the same manipulations must be employed in "packing" the shot in each case, else very considerable differences in the measurements will be the result. Adopting some such method, and it is of advantage to use that most commonly employed, viz., that recommended by Broca, as the results are then comparable with other observations, it has been found that the cranial capacity in man ranges from 1000 cubic centimètres to 1800 c.c. Comparing this with what we observe in apes, we find that the man with the lowest capacity, viz., 1000 c.c., has a capacity twice that of the highest apes, for in gorillas we find a capacity of only 500 c.c. or thereabouts, whilst orangs and chimpanzees are considerably lower, with capacities of 430 c.c. and 420 c.c. respectively, though one must not overlook the fact that their body weight is much less than that of the gorilla.

For convenience of classification, calvaria are grouped according to their capacities. Those with a capacity below 1350 c.c. are termed microcephalic, those between 1350 c.c. and 1450 c.c. are mesocephalic, whilst those of 1450 c.c. are called megacephalic.

The first group (microcephalic) include Australians, Tasmanians, aborigines of India, Veddahs, Bushmen, Hottentots, Andamanese, Akkas, and other pigmy races. The mesocephalic comprise Malays, American Indians, and African Negroes; whilst the megacephalic races are composed of Europeans, ancient Egyptians, Mongolians, mixed Polynesians, Eskimo, Kaffirs, and Zulus.

In considering the question of cranial capacity the matter of sex must not be omitted. The average difference between the male and female capacities is 150 c.c.—the male having the advantage. The fact, however, must not be overlooked that women are not so tall as men, and therefore we would not expect them to have such large heads; but even making allowance for the difference in height the female capacity is still relatively less than that of man. The average weight of man's brain is about fifty ounces, that of woman about forty-five ounces. This difference between the sexes is less marked in savage than in civilized races, and is apparently explained by the fact that in the higher races more attention is paid to the education of the male than the female, and, consequently, the brain is stimulated to increased growth. It will be interesting to note whether in view of the recent developments in the education of women she will be able to equalise matters as regards her fair share of brains. It is hardly necessary to point out that quantity is no criterion of quality, and though the brains of many distinguished



A. B. C.

Fig. 1 displays the differences in size and cranial capacity met with in Skulls. A is a large English Skull, with a cranial capacity of 1680 c.c.; it is, therefore, megacephalic. B is a German Skull, with a cranial capacity of 1400 c.c.; it is, therefore, mesocephalic. C is the Skull of an Andaman Islander, with a cranial capacity of 1040 c.c.; therefore microcephalic.

men have weighed much above the average (that of Cuvier weighed sixty-four ounces), there are abundant examples of equally weighty brains the possessors of which were not characterised by wits above the common herd. For our part we would rather that women remained as they are, for a small and shapely head is a feature of feminine beauty, and what they lack in quantity they may well make up in quality.

But apart from the mere size of the cranium we have to consider its shape. If a number of skulls be taken and placed on the floor so that we can look down upon them, we will at once realize that they display a great diversity of form, provided always that we are dealing with mixed groups; some are long and narrow, whilst others are broad and rounded. We hardly need to make this observation to bring the fact home to us, it is only necessary to remind

the reader how easily he recognises his own hat by the accuracy of its fit.

For descriptive purposes the long heads are called dolichocephalic, the round head brachycephalic.

It is noteworthy that this peculiarity is not confined to man. Of the anthropoid apes the gorilla and chimpanzee are dolichocephalic, the orangs and gibbons brachycephalic, and it has been pointed out as an interesting coincidence, if nothing more, that the races of men corresponding to the geographicical distribution of these apes have the same peculiarities of head form. But whilst much stress was formerly laid on this difference in head form as a racial characteristic, the trend of modern opinion seems to be that too much reliance must not be placed on this distinction. As we have said, the size, and to some extent the form of the calvaria, depends on the development of the brain, at the same time we hinted that the shape of the brain case was to some extent correlated with the masticatory apparatus, for in those cases where we have large teeth and big jaws we necessarily require powerful muscles to act upon them, and these by their size and development necessarily react on the surfaces to which they are attached. As a rule in brachycephalic skulls the fossæ for the attachment of the temporal muscles are low and shallow, whereas in dolichocephalic skulls they are high and deep.

Another factor which determines the shape of the calvaria must not be overlooked. As Virchow has pointed out, the form of the skull depends to some extent on the order in which the sutures or joints which unite the several bones become closed, compensation always taking place in the direction of the suture, thus if one of the longitudinal sutures, the sagittal, for instance, becomes early synostosed the skull tends to grow long and narrow; if, on the other hand, one of the transverse sutures becomes ossified the skull can no longer increase in length, but expands transversely, forming a round and broad head. Apart from the question of heredity, which no doubt exercises a powerful influence, any one of the foregoing causes may determine remarkable individual variations of form.

For scientific purposes these differences in shape are recorded by the use of what is termed the cephalic index. This expresses the proportion of the width of the skull to its length, taking the latter as equivalent to one hundred; thus, supposing a "round" skull was strictly circular, its width would be equal to its length, *i.e.*, one hundred. On the other hand, if the width of the skull was only half its length, *i.e.*, fifty, the form of the calvaria would be an elongated oval, that is to say, long headed. Such extremes as those above mentioned are not met with in practice, but the example stated may serve to illustrate the method. As will be seen, this plan of grouping skulls is to some extent a compromise, and is open to certain grave objections. We assume that the length of the skull is the constant and the width the variable, whereas we might with equal reason adopt the transverse diameter of the skull as the constant and the antero-posterior length as the variable. Furthermore, though the index expresses the proportion of the width to the length, it by no means follows that it enables us to map out with any accuracy the outline of the skull; it merely enables us to say that we could place the skull within a cube the length and width of which correspond to the proportions expressed by the index, just as if we were making a box in which to pack the skull. The accompanying diagram illustrates this; both skulls have the same cephalic index though their shape is entirely different.

It will thus be seen that the cephalic index merely indicates the proportion of width to length, and fails to convey any accurate impression of contouring. Were we able to locate with precision the point of greatest width in relation to the length of the skull, the results would be more valuable, but unfortunately any such attempt would be beset with considerable difficulties.

In practice, the cephalic index is obtained by the following formula:—

$$\frac{\text{Breadth} \times 100}{\text{Length}} = \text{Cephalic Index.}$$

The results are grouped as follows:—Skulls with a proportionate width of eighty or over are termed *Brachycephalic*. This group includes, among others, some Mongolians, Burmese, American Indians, and Andamanese.

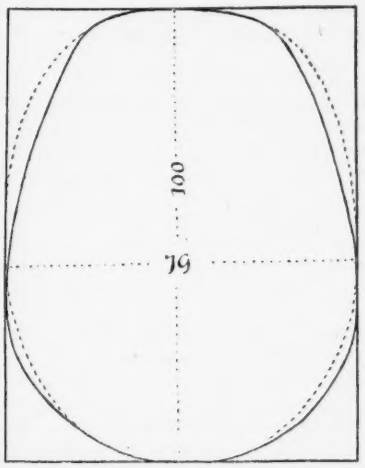
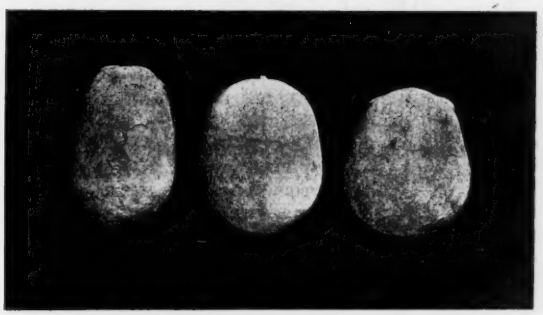


Fig. 2 represents two Skulls having the same cephalic index—viz., 79—yet displaying very different forms.

Skulls of which the index lies between seventy-five and eighty are *Mesaticephalic*, comprise Europeans, Ancient Egyptians, Chinese, Japanese, Polynesians, Bushmen, &c.

Whilst skulls with a proportionate width below seventy-five are *Dolichocephalic*, and are more or less typical of Veddahs, Eskimo Australians, African Negroes, Kaffirs, Zulus, &c.

The accompanying illustration shows three typical



A. B. C.

Fig. 3 shows examples of three varieties of Skull form. A. Extremely dolichocephalic Skull of Veddah, index 64; B. Mesaticephalic Italian Skull, index 79; C. Brachycephalic Swiss Skull, index 88.

examples of the variety of form characteristic of the three groups above mentioned.

SIR MICHAEL FOSTER'S PRESIDENTIAL ADDRESS TO THE BRITISH ASSOCIATION,

September 13th, 1899.

In an address of singular literary grace, Sir Michael Foster, at Dover, last month, reminded us that some of the most fruitful advances effected in chemistry, geology, and electricity, were made at the very close of the eighteenth century, and that the concrete achievements of the present are the transla-

XUM

tion into fact of the purely intellectual efforts of Lavoisier and Priestley, of Galvani and Volta, of Hutton and of Cuvier.

Sir Michael said "the Association has seen pass away the men who, wise in their generation, met at York on September 27th, 1831, to found it; it has seen other great men who in bygone years served it as presidents, or otherwise helped it on, sink one after another into the grave. Each year, indeed, when it plants its flag as a signal of its yearly meeting, that flag floats half-mast high in token of the great losses which the passing year has brought. This year is no exception; the losses, indeed, are perhaps unwontedly heavy.

The eyes of the young look ever forward; they take little heed of the short though ever-lengthening fragment of life which lies behind them; they are wholly bent on that which is to come. The eyes of the aged turn wistfully again and again to the past; as the old glide down the inevitable slope their present becomes a living over again the life which has gone before, and the future takes on the shape of a brief lengthening of the past. They who study the phenomena of living beings tell us that light is the great stimulus of life, and that the fulness of the life of a being or of any of its members may be measured by the variety, the swiftness, and the certainty of the means by which it is in touch with its surroundings. I do not propose to weary you by what in my hands would be the rash effort of attempting a survey of all the scientific results of the nineteenth century. It will be enough if for a little while I dwell on some few of the salient features distinguishing the way in which we nowadays look upon, and during the coming week shall speak of, the works of Nature around us—though those works themselves, save for the slight shifting involved in a secular change, remain exactly the same—from the way in which they were looked upon and might have been spoken of at a gathering of philosophers at Dover in 1799. And I ask your leave to do so.

In the philosophy of the ancients, earth, fire, air, and water were called "the elements." It was thought, and rightly thought, that a knowledge of them and of their attributes was a necessary basis of a knowledge of the ways of Nature. Translated into modern language, a knowledge of these "elements" of old means a knowledge of the composition of the atmosphere, of water, and of all the other things which we call matter, as well as a knowledge of the general properties of gases, liquids, and solids, and of the nature and effects of combustion. Of all these things our knowledge to-day is large and exact, and though ever enlarging, in some respects complete. When did that knowledge begin to become exact? Let me ask you to picture to yourselves what confusion there would be to-morrow, not only in the discussions at the sectional meetings of our Association, but in the world at large, if it should happen that in the coming night some destroying touch should wither up certain tender structures in all our brains, and wipe out from our memories all traces of the ideas which cluster in our minds around the verbal tokens, oxygen and oxidation. How could any of us, not the so-called man of science alone, but even the man of business and the man of pleasure, go about his ways lacking those ideas? Yet those ideas were in 1799 lacking to all but a few. Although in the third quarter of the seventeenth century the light of truth about oxidation and combustion had flashed out in the writings of John Mayow, it came as a flash only, and died away as soon as it had come. For the rest of that century, and for the greater part of the next, philosophers stumbled about in darkness, misled for the most of the time by the phantom conception which they called phlogiston. It was not until the end of the third quarter of the eighteenth century that the new light—which has burned steadily ever since—lit up the minds of the men of science. The light came at nearly the same time from England and from France. Rounding off the sharp corners of controversy, and joining, as we may fitly do to-day, the two countries as twin bearers of a common crown, we may say that we owe the truth to Cavendish, to Lavoisier, and Priestley. If it was Priestley who was the first to demonstrate the existence of what we now call oxygen, it is to Lavoisier we owe the true conception of the nature of oxidation and the clear exposition of the full meaning of Priestley's discovery, while the knowledge of the composition of water, the necessary complement of the knowledge of oxygen, came to us through Cavendish and, we may perhaps add, through Watt. The date of Priestley's discovery of oxygen is 1774. Lavoisier's classic memoir "on the nature of the principle which enters into combination with metals during calcination" appeared in 1775, and Cavendish's paper on the composition of water did not see the light until 1784. During the last quarter of the eighteenth century this new idea of oxygen and oxidation was struggling into existence. How new was the idea is illustrated by the fact that Lavoisier himself at first spoke of that which he was afterwards—namely, in 1778—led to call oxygen, the name by which it has since been known, as "the principle which enters into combination." What difficulties its acceptance met with is illustrated by the fact that Priestley himself refused to the end of his life to grasp the true bearings of the discovery which he had made. In the year 1799, the knowledge of oxygen, of the nature of water and of air, and, indeed, the true conception of chemical composition and chemical change was hardly more than beginning to be, and the century had to pass wholly away before the next great chemical idea, which we know by the name of the atomic theory of John Dalton, was made known.

If there be one word of science which is writ large on the life of the present time, it is the word "electricity"; it is, I take it, writ larger than any other word. The knowledge which it denotes has carried its practical results far and wide into our daily life, while the theoretical conceptions which it signifies pierce deep into the nature of things. At what time did this bright child of the nineteenth century have its birth? He who listened to the small group of philosophers of Dover, who in 1799 might have discoursed of natural knowledge, would perhaps have heard much of electric machines, of electric sparks, of the electric fluid, and even of positive and negative electricity; for frictional electricity had long been known and even carefully studied. Probably one or more of the group, dwelling on the observations which Galvani, an Italian, had make known some twenty years before, developed views on the connection of electricity with the phenomena of living bodies. Possibly one of them was exciting the rest by telling how he had just heard that a professor at Pavia, one Volta, had discovered that electricity could be produced not only by rubbing together particular bodies, but by the simple contact of two metals, and had thereby explained Galvani's remarkable results. For, indeed, as we shall hear from Professor Fleming, it was in that very year, 1799, that electricity as we now know it took its birth. It was then that Volta brought to light the apparently simple truths out of which so much has sprung. And even Volta's discovery might have long remained relatively barren had it been left to itself. When, however, in 1819, Oersted made known his remarkable observations on the relations of electricity to magnetism, he made the contact needed for the flow of a new current of ideas.

Of all the various branches of science, none, perhaps, is to-day, none for these many years past has been, so well known to, even if not understanded by, most people as that of geology. Its practical lessons have brought wealth to many; its fairy tales have brought delight to more; and round it hovers the charm of danger, for the conclusions to which it leads touch on the nature of man's beginning. In 1799 the science of geology, as we now know it, was struggling into birth. There had been from of old cosmogonies, theories as to how the world had taken shape out of primeval chaos. The brilliant Stenson, in Italy, and Hooke, in our own country, had laid hold of some of the problems presented by fossil remains, and Woodward with others, had laboured in the same field. In the eighteenth century, especially in its latter half, men's minds were busy about the physical agencies determining or modifying the features of the earth's crust; water and fire, subsidence from a primeval ocean and transformation by outbursts of the central heat, Neptune and Pluto, were being appealed to, by Werner on the one hand, and by Desmarest on the other, in explanation of the earth's phenomena. In 1783, James Hutton put forward in a brief memoir his "Theory of the Earth," which in 1795, two years before his death, he expanded into a book; but his ideas failed to lay hold of men's minds until the century had passed away, when, in 1802 they found an able expositor in John Playfair. The very same year that Hutton published his theory, Cuvier came to Paris and almost forthwith began, with Brongniart, his immortal researches into the fossils of Paris and its neighbourhood. And four years later, in the year 1799 itself, William Smith's tabular list of strata and fossils saw the light. It is, I believe, not too much to say that out of these geology, as we now know it, sprang.

In another branch of science, in that which deals with the problems presented by living beings, the thoughts of men in 1799 were also different from the thoughts of men to-day. It is a very old quest, the quest after the knowledge of the nature of living beings, one of the earliest on which man set out; for it promised to lead him to a knowledge of himself, a promise which, perhaps, is still before us, but the fulfilment of which is as yet far off. Yet in the past hundred years, the biologic sciences, as we now call them, have marched rapidly onward. We may look upon a living body as a machine doing work in accordance with certain laws, and may seek to trace out the working of the inner wheels, how these raise up the lifeless dust into living matter, and let the living matter fall away again into dust, giving out movement and heat. Or we may look upon the individual life as a link in the long chain, joining something which went before to something about to come, a chain whose beginning lies hid in the furthest past, and may seek to know the ties which bind one life to another. As we call up to view the long series of living forms, living now, or flitting like shadows on the screen of the past, we may strive to lay hold of the influences which fashion the garment of life. Whether the problems of life are looked upon from the one point of view or the other, we to-day, not biologists only, but all of us, have gained a knowledge hidden even from the philosophers of a hundred years ago. Of the problems presented by the human body viewed as a machine, some may be spoken of as mechanical, others as physical, yet others as chemical, while some are, apparently at least, none of these. In the seventeenth century, William Harvey, laying hold of the central mechanism of the blood stream, opened up a path of inquiry which his own age and the century which followed trod with marked success. The philosopher of 1799, when he discussed the functions of the animal or of the plant involving chemical changes, was fain for the most part, as were his predecessors in the century before, to have recourse to such vague terms as "fermentation" and the like; to-day our treatises on physiology are largely made up of precise and exact expositions of the play of physical agencies and chemical bodies in the living organism. He made use of the words "vital force" or "vital principle" not as an occasional, but as a common explanation of the phenomena of the living body. During the present century, especially during its latter half, the idea embodied in those words has been driven away from one seat after another; if we use it now when we are dealing with the chemical and physical events of life we use it with reluctance, as a *deus ex machina* to be appealed to only when everything else has failed.

During the latter part of the present century, and especially during its last quarter, the analysis of the mysterious processes in the nervous system, and especially in the brain, which issue as feeling, thought, and the power to move, has been pushed forward with a success conspicuous in its practical, and full of promise in its theoretical, gains. We now know that what takes place along a tiny thread which we call a nerve-fibre differs from that which takes place along its fellow-threads, that differing nervous impulses travel along different nerve-fibres, and that nervous and psychical events are the outcome of the clashing of nervous impulses as they sweep along the closely-woven web of living threads of which the brain is made. We have learnt by experiment and observation that the pattern of the web determines the play of the impulses, and we can already explain many of the obscure problems not only of nervous disease, but of nervous life, by an analysis which is a tracking out the devious and linked paths of nervous threads. The very beginning of this analysis was unknown in 1799. Men knew that nerves were the agents of feeling and of the movements of muscles; they had learnt much about what this part or that part of the brain could do; but they did not know that one nerve fibre differed from another in very essence of its work.

If we pass from the problems of the living organism viewed as a machine to those presented by the varied features of the different creatures who have lived or who still live on the earth, we at once call to mind that the middle years of the present century mark an epoch in biologic thought such as never came before, for it was then that Charles Darwin gave to the world the "Origin of Species." That work, however, with all the far-reaching effects which it has had, could have had little or no effect, or, rather, could not have come into existence, had not the earlier half of the century been in travail preparing for its coming. For the germinal idea of Darwin appeals, as to witnesses, to the results of two lines of biologic investigation which were almost unknown to the men of the eighteenth century. Darwin, as we know, appealed to the geological record; and we also know how that record, imperfect as it was then, and imperfect as it must always remain, has since his time yielded the most striking proofs of, at least, one part of his general conception. In 1799 there was, as we have seen, no geological record at all. All or nearly all the exact knowledge of the laboured way in which each living creature puts on its proper shape and structure is the heritage of the present century. Although the way in which the chick is moulded in the egg was not wholly unknown, even to the ancients, and in later years had been told, first in the sixteenth century by Fabricius, then in the seventeenth century in a more clear and striking manner by the great Italian naturalist Malpighi, the teaching thus offered had been neglected or misinterpreted. At the close of the eighteenth century the

XUM

dominant view was that in the making of a creature out of the egg there was no putting on of wholly new parts, no epigenesis. It was taught that the entire creature lay hidden in the egg, hidden by reason of the very transparency of its substance, lay ready made but folded up, as it were, and that the process of development within the egg or within the womb was a mere unfolding, a simple evolution. Nor did men shrink from accepting the logical outcome of such a view—namely, that within the unborn creature itself lay in like manner, hidden and folded up, its offspring also, and within that again its offspring in turn, after the fashion of a cluster of ivory balls carved by Chinese hands, one within the other.

I have said, I trust, enough to justify the statement that in respect to natural knowledge a great gulf lies between 1799 and 1899. That gulf, moreover, is a two-fold one; not only has natural knowledge been increased, but men have run to and fro spreading it as they go. Whoever, working at any scientific problem, has occasion to study the inquiries into the same problem made by some fellow-worker in the years long gone by, comes away from that study humbled by one or other of two different thoughts. On the one hand, he may find, when he has translated the language of the past into the phraseology of to-day, how near was his forerunner of old to the conception which he thought, with pride, was all his own, not only so true, but so new. On the other hand, if the ideas of the investigator of old, viewed in the light of modern knowledge, are found to be so wide of the mark as to seem absurd, the smile which begins to play upon the lips of the modern is checked by the thought—Will the ideas which I am now putting forth, and which I think explain so clearly, so fully, the problem in hand, seem to some worker in the far future as wrong and as fantastic as do these of my forerunner to me?"

TWO MONTHS ON THE GUADALQUIVER.

By Harry F. Witherby, F.Z.S., M.B.O.U.

IV.—SCRUB AND WOOD.

A WOODED portion of the *marismas* was briefly referred to in my last article (Knowledge, August 1899), and as this part of the country is interesting from several points of view, a more detailed description of it and of its wild inhabitants may prove acceptable.

Our first day's work in this scrub and wood was as novel to us as had been our first day's stalking behind the *cabestro*. We were fortunate in having as headquarters a large rambling old house, from which we set out accompanied by two keepers and a boy, all on horseback—an imposing cavalcade, surely, for a bird-nesting expedition. But to have a smaller escort in Spain would be considered *infra dig*, while to walk when there are horses to ride would be altogether out of the question. We were loth to depart from the customs of the country, and, therefore, consented to this arrangement. As we rode in single file along narrow pathways, through a growth of tamarisk, gorse, and other plants, as high as our horses' heads, and, in many places, quite impenetrable, or as we spread out in different directions to search for birds' nests, we began to understand the advantage of the Spanish system of bird-nesting. From horseback we could see over the high cover, and so guide our way to the most likely looking spots. On a horse, too, one can cover more ground in a day than on foot, which is a great advantage in a big country with a burning sun; and, again, one feels more comfortable on a horse when suddenly confronted by a fierce-looking wild sow with her litter—at all events, such was our experience. Dotted about here and there in the midst of the tamarisk were small groups of cork oak trees, and to the exploration of these we devoted our first day. Every tree contained a bird or a nest, and in many cases several birds were breeding in the same tree. We discovered many nests of both the red and black kites, and found another use for our horses in climbing up to them. The lower part of a tree is generally branchless, and so the most difficult to climb. By standing up on your saddle a bough is generally within reach, and thus the difficulty is overcome, provided the horse does not move away at the critical moment. Most of the red kites at this date (April 22nd) had young ones, clothed in dull white down and with beaks and legs apparently many sizes too big for their strength and age. The few eggs of the red kite which we found were much incubated, whereas those of the black kite were all fresh.

The first red kite's nest found was near the top of a cork oak tree. It was about the size of a rook's nest, but much flatter, and was built of sticks and lined with dung. It was swarming with ants which had climbed the tree, and contained three young birds, one of them covered with a half-eaten rat, while the others were nestling against the remains of a couple of small rabbits. The nest was decorated with bits of newspaper and dirty rags and strips of old linen, some of which, hanging down from projecting sticks, fluttered like pennants in the breeze.

Other nests contained by way of larder the remains of snakes and coots. All were not lined with dung, but every one was adorned, even in places far from any human habitation, with the "lesser linen," which Shakespeare bids us look to when the kite breeds. The black kite's nest differs little from that of its relation, except that it is less ornamental and sometimes contains no rags at all.

Green woodpeckers,* of a species very nearly allied to that found in England, were abundant amongst the cork oaks, as were jackdaws,† while now and again a brilliant blue roller‡ would glide up into a thick tree, or a golden oriole,§ always shy, would give us a glimpse of his glorious black and gold as he dipped away into another tree to resume his mellow piping. An occasional view of these brilliantly coloured birds amongst the trees, and the bee-eaters,‖ with their gorgeous rainbow hues, flying round like swallows in the open, gave the whole place quite a tropical aspect. But without the brilliant sun the metallic blues and greens of the bee-eater are dull and brown, and it is only when the sun is shining full upon it that one sees all the gorgeous colouring of the bird as it hovers and floats and turns in the air. It seems a sin that a bird should be destroyed simply because of its beauty; but so it is—fashion demands it—and thousands of bee-eaters are annually snared and roughly skinned by the Spanish natives who sell them to the milliners in Paris. We saw a bee-eater going through the most extraordinary antics in the air and then perch on a tree to gasp for breath. We shot the bird, and found round its neck a horsehair noose attached to a small peg. Bee-eaters lay their eggs in a tunnel which they are at some pains to bore into a bank or into flat ground. The natives place nooses, fastened to a peg driven into the ground, over these nesting holes, so that when the bird emerges it is caught and strangled. The bird which we shot had evidently loosened the peg and flown away with a burden from which nothing but death could release it.

* *Gecinus sharpii.* † *Corvus monedula.* ‡ *Coracias garrulus.*
§ *Oriolus galbula.* ‖ *Merops apiaster.*

But notwithstanding this wealth of colour, melody was not wanting, for everywhere nightingales* poured forth their songs, although certainly not such full-toned ones as we have in England. Now and again we heard a soft "hoo-hoo," and an occasional hiss, and found the performer a hoopoe,† strutting about, proudly raising its beautiful crest.

Amongst others of the many birds we saw were several little owls.‡ One of these comical little birds allowed us to ride right up to it, as it sat in a small tree. We stared hard at it, and it stared hard at us, with its yellow eyes. I almost touched the bird with the muzzle of my gun, whereat it flew off to another tree, and proceeded to hurl screeches and whoo-whoos at us.

We did not always ride about this country; indeed, we found a long lonely walk often a great relief, and a great advantage, for one cannot observe small birds from horseback, besides which, our horses, although hobbled at night, would sometimes be driven by flies and mosquitoes to a worse torment—a leech-infested marsh—and, as a consequence, would appear in the morning only fit (as the keepers remarked) for the bull ring.

One of these lonely walks may be worth recording. I had been forcing my way through the thickest cover for some miles without seeing anything but a stag or two (where wild boars are common, the crash of a stag, as it jumps up within a yard of one, is rather disconcerting), when I came upon a clump of cork trees. I crept cautiously up to them. The first tree contained nothing, but near the top of the second there sat a great griffon vulture. I coveted his skin, although I had no wish to skin him myself, as those who know what a griffon vulture is will understand. However, I fired, and down fell a very mountain of flesh and feathers. He was not dead, so I put a charge of small shot into his head, at which he sank down, and apparently died. But it is even easier to kill a cat than a big vulture. I was sitting down with my back to the vulture, eating lunch, and considering how I could carry him home, when I heard a great rustling, and there was my "dead" bird hobbling off, drooping its broken wing. I leisurely picked up my things and was proceeding to follow the vulture when it disappeared into the thickest part of the scrub. It seems incredible that one could lose a badly wounded bird as large as a turkey in scrub however thick. Nevertheless I did lose that bird, and was never able to find it again, notwithstanding many hours of diligent searching. My search, it is true, was somewhat distracted, firstly, by a large eyed lizard,§ about two feet long, which was sunning itself on a little patch of bare sand, from which it made off on my approach with an ungainly gallop, like a young crocodile. Then I heard a harsh noise going on behind me. I turned and saw a serpent eagle‖—a small light-coloured eagle—hovering over a tree from which sounded a shrill "tic-tic-tic." Suddenly it closed its wings and went down into the tree like a stone. Presently it rose again and flew away, while the "tic-tic-tic" again sounded from the tree. I crept forward and out flew another eagle from a nest in the tree. The nest was compactly made of stout twigs, and had for a lining a number of acorn cups and a long clean backbone of a snake, but there were no eggs. On visiting this nest again some days afterwards it was still empty, and the snake's skeleton had disappeared.

The griffon vulture was not the only bird that came to life again, so full of surprises to us was this strange country. We were sitting one evening "picking oakum," not from inclination but from necessity, having run short of tow wherewith to fill up our bird skins, when a kite, which had been shot some hours before, and was just about to be skinned, suddenly got up from the floor, and flew round the room. Verily the ornithologist requires strong nerves.

We made several expeditions amongst the sandhills bordering on the sea. The markings on the surface of these sandhills are well worth studying. Everywhere the tracks of cows, horses, deer, and rabbits are to be seen. Look a little closer at the sand, and you will find that its whole surface is covered with smaller tracks, crossing and re-crossing each other. You can decipher those of birds of different kinds, lizards, large and small, as well as tortoises, but there still remain to be accounted for a vast number of intricate dots, lines, marks, and trails, which may have been made by mammals, birds, reptiles, or even insects. Here and there amongst the sandhills is a pine wood, which still holds out against the all-embracing sand. In these stunted pine trees we found kites' nests, as well as those of ravens,* not more than twenty feet from the ground. The raven is well known as a very early breeder in England, often having eggs in the beginning of March, but in Spain, although so many miles further south, we found fresh eggs on April 26th, and slightly incubated ones as late as May 11th. It is possible, of course, that the bird has two broods in Spain, but I think it unlikely, as we never saw any young ravens about.

As we were riding one day across these sandhills, a great black eagle—the Spanish Imperial eagle†—rose in front of us and flew away with a big straggling mass of white in its claws. We followed it, anxious to discover what was its prize; and we were not the only being who watched the great bird with interest. No sooner had it settled again than four kites and two ravens flew down and stood near at hand, whilst several more kites swooped round and round in the air. The eagle, rending and devouring his prey, took no notice, but the kites and ravens watched his every movement, afraid to attack, but still expecting a share of the booty. At last we fired a shot from our hiding place. The eagle was so surprised that he dropped his quarry and soared away on high in giant circles, while the kites and ravens disappeared as if by magic. The straggling white mass was a half-eaten spoonbill, a bird nearly as big as the eagle itself.

There are two kinds of magpies in Spain, our common magpie‡ and the Spanish or azure-winged magpie.§ We found many nests of the common magpie. They were all built in low bushes, and none of them had the dome, which is the chief characteristic of the magpie's nest in England, as well as, I believe, in every other country it inhabits. Why the magpie should build a roofless, unprotected nest in a country swarming with egg-eating and chick-stealing birds is a puzzle towards the solution of which I have no suggestions to offer.

The Spanish magpie occurs only in the Iberian Peninsula, and is even there very locally distributed. We met with it in considerable numbers amongst pines and wild olives some long way from the riverside. Of a most delicate blue in general colouring, with a velvety jet-black head and a long elegant tail, it is one of the most beautiful birds. In habits it reminds one much of the jay, especially in the way in which the birds go about in small parties chattering loudly, always keeping just ahead of one, and out of sight in the tree tops. We had many opportunities, however, of surprising the magpies when feeding on the ground.

* *Daulias luscinia.* † *Upupa epops.* ‡ *Athene noctua.*
§ *Lacerta occellata.* ‖ *Circaetus gallicus.*

* *Corvus corax.* † *Aquila adalberti.* ‡ *Pica rustica.*
§ *Cyanopica cooki.*

Like the fieldfare and other birds they are very sociable, and if one nest is found several others will be discovered in neighbouring trees. All the nests we saw were built in small pine trees, and were made of a silvery flower interwoven with twigs of pine, the inside being lined with red cows' hair—a beautiful nest for a beautiful bird.

It would weary the reader to be told of all the charming and interesting birds that we saw in this wonderful country, but I cannot refrain from telling of an eagle and its nest.

We were riding home after a hard day's work, when we spied a large black bird sitting near the top of a cork tree some distance off. The keepers proclaimed it a *cuerbo* or raven, but a glance through our binoculars told us it was something better. Accordingly, we made a wide circuit until we had placed the tree between ourselves and the bird. Then we dismounted and crept as quietly as possible through the cover until we were under the tree. Here an unforeseen difficulty presented itself. The tree was so thick that we could not at first see the bird. At length we caught sight of it sitting all unconscious above our heads. We fired, and down it dropped, not to ground but into a great nest which we had not seen just below it.

It did not take us many seconds to reach that nest. It was just a flat platform, some six feet across, and was made of green boughs. In it was the great bird we had shot lying stone dead—a Spanish Imperial eagle—while near the old bird were two young ones clad in soft white down, and a little distance from them a great round dirty-white egg. There was room in the nest for a couple of sheep, but the eagle's larder contained nothing more than a few rabbits and the legs of a coot.

A good idea of the wild character of the country may be gathered from the fact that this nest was within a mile of the house in which we were staying, and yet the keepers had no suspicion that one of the most deadly game destroyers had taken up its quarters there.

THE KARKINOKOSM, OR WORLD OF CRUSTACEA.—XI.

By the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S., F.Z.S., *Author of "A History of Crustacea," "The Naturalist of Cumbrae," "Report on the Amphipoda collected by H.M.S. 'Challenger,'" etc.*

TASTE AND TRY.

A BOY gathering limpets on the shore in Devonshire, being questioned about them, remarked that they were "very good raw, but better boiled." That is a maxim which will not fit all the mollusca in either of its alternatives, and only fits the crustacea in one of them. For while unsophisticated aquatic animals find crustaceans very good raw, human beings exhibit a quite unwonted unanimity in fancying them better boiled.

The unanimity of mankind seldom runs to excess. Foreign nations often presume to have customs different from ours. They have the temerity, for example, to use for food many species from the karkinokosm which are quite unknown to the English public. As, however, one object of these papers has been to inform and widen the taste for a neglected class, some mention ought to be made of the species deemed palatable in other climes.

The Thyrostraca, or Cirripedes, discussed in a previous chapter, might seem a group as unlikely as any to supply specimens to tempt the appetite of mankind. Notwithstanding their extreme abundance on and about our own coasts, there are no purveyors of them for the home market. Yet *Balanus psittacus*, Molina, is eaten and relished in South America. It is an acorn barnacle, not unlike the sorts common with us, only monstrously big by comparison. But then the rule with crustaceans for table is, the bigger the better, you can't have too much of a good thing. At any rate we are told that from Peru to Patagonia people eat the big *Balanus* and find it delicious, when cooked. Those, therefore, among ourselves who are in search of a new sensation or a new flavour have an encouraging precedent for trying what is to be got out of boiled barnacles.

There are few records which speak in favour of Entomostraca as comestibles. Curiosity has tasted them, and perceived in them a fairly acceptable reminiscence of shrimps. But, like the child who thought the making of flies must be fiddling work, the consumers of Copépoda appear to find them fiddling food. It takes many to make a mouthful. Some of them are excessively oily. We may be content to let them fatten our herrings and other useful fishes, we ourselves in this way more conveniently devouring them at second hand, like those august oriental potentates who drink the kava prepared by the mouths of their menials.

For more substantial banquets we must have recourse to the Malacostraca. Still among these what may be called the lower orders, the sessile-eyed groups, enter very little into an Englishman's calculation of food supply. The Isopoda may be said to be quite out of it, although woodlice, such as the Slaters (*Porcellio*) and the Pill-Millepeds (*Armadillidium*), were once of much repute in medicine. In the latter genus the animal faces danger by rolling itself up into a ball. Here, then, was a little shining pill, evidently moulded by Nature for curative purposes. Modern human prejudice rejects the useless remedy with disgust, whereas the better informed barndoor fowl eats this small game with avidity, not as a medicine, but as a substitute for the unattainable lobster. The Amphipoda have won rather more appreciation as food for man. Thus Risso, in 1826, describing the curious *Phrosina semilunata*, remarks of it that the flesh is tender and well-tasted, and that it might well supply a dish to those who dwell on the shores of the Mediterranean, where it occurs in abundance. Risso does not say that either he himself or any one else ever had such a dish, but, for all that, an English author subsequently cites him as affirming that "these crustacea are eaten as a luxury, and, moreover, serve as an article of food to the inhabitants on the shores of the Mediterranean." It would be a tempting improvement to declare that those inhabitants never eat anything else. It is more to the purpose to repeat the Prince of Monaco's recommendation to the shipwrecked, not to neglect the species of *Hyperia*, which may be obtained from jelly fishes in the open sea. That the great amphipods, which abound in Arctic waters, would pleasantly satisfy man's appetite on an emergency can scarcely be doubted. The indiscriminating seal swallows them whole, as we know by specimens recovered in good condition from the seal's stomach. The amphipods, in revenge, if they meet with a dead seal, make short work of its carcase—a devouring crowd compelled by the nature of their jaws to savour and enjoy every morsel of the much-divided feast.

Passing on to the stalk-eyed group, we find a general recognition of the culinary merit contained within it, though few know how great is the number of extremely different species over which that merit is diffused. In Great Britain we never get a chance of tasting any of the Squillidæ. To an uneducated eye, a dish of them might look rather repellent, and an uneducated ear might be horrified at an invitation to eat Stomatópoda. That order comprises the single family of the Squillidæ. One at least of

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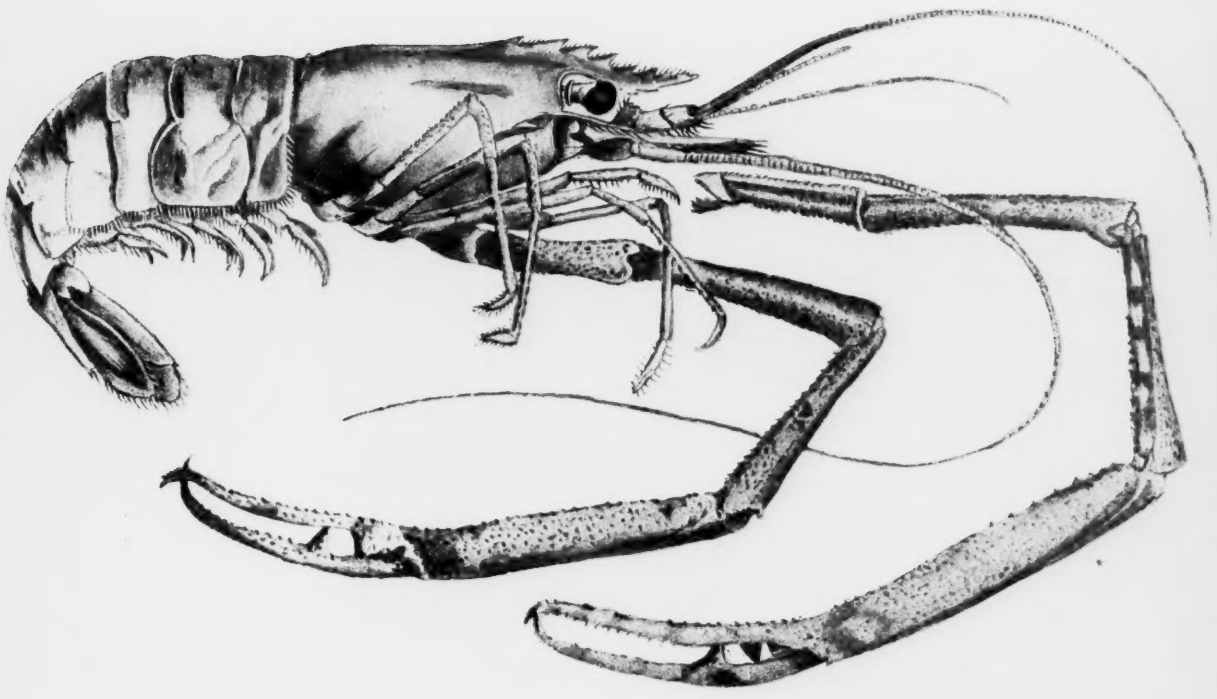
ARCTIC SHRIMP, Natural Size. *Sclerocrangon ferox* Sars. From Sars.



ORIENTAL RIVER PRAWN, Natural Size. *Palæmon lar* Fabricius. From Spence Bate.

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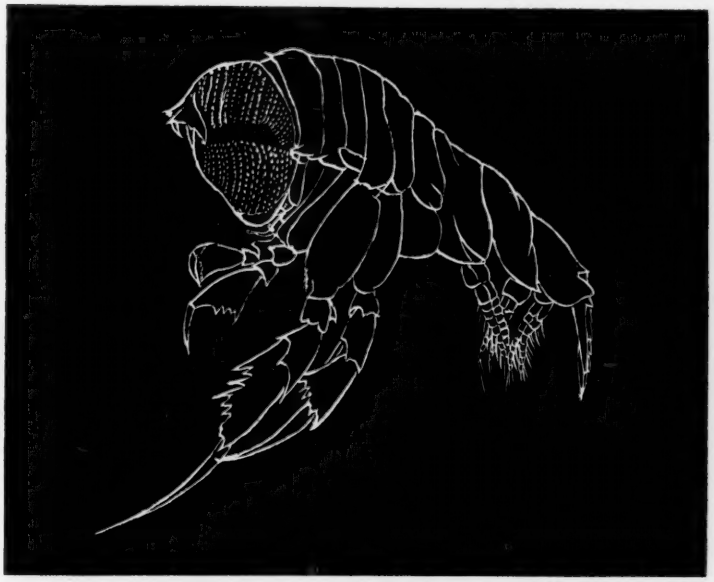
the species, *Squille mantis*, is abundant in the Mediterranean, nor can there be any doubt that among the border tribes of that favoured lake it is commonly eaten, and its meat considered uncommonly good.

In the case of the Crustacea Macrura, qualms are less likely to arise. There is so great a general resemblance among numerous species respectively of shrimp or prawn



Phrosina semilunata, Risso. (Magnified.)

or lobster that ignorance raises a barrier against repugnance. All unawares we might be tricked into eating a *Pandalus montagui* in mistake for a common prawn. Against practical jokes of this kind, the only true defence is a diligent study of the karkinokosm. Even in England prawns and shrimps of several species are sold without distinction, so that the heedless may at any time be mixing up *Leander serratus* (Pennant) and *Leander squilla* (Linn.) "in their midst" without knowing it. On the Continent they have a prawn which is neither a *Pandalus* nor a *Leander*, but a *Penæus*. This is affirmed to be of much finer flavour than the common lobster or crayfish, As the names just quoted indicate, prawns belong to more than one genus. By many names men call them, in many seas they dwell. They are, in fact, so divided up into genera and species that none with a light heart can hope to know them all, each clearly apart from the rest. They do not all live in the ocean, but many in fresh waters. They are not all of one size, but some large as lobsters. Some have three pairs of their legs fashioned into chelipeds, some only two. In some the chelipeds of one pair are enormously elongated. Some have the eyes boldly prominent. In others, as *Alphéus*, the eyes are beneath, just gleaming through, the semi-pellucid carapace. The great river prawn of tropical America, *Palæmon jamaicensis* (Herbst), is freely eaten. In regard to Colima, in Mexico, Miss M. J. Rathbun quotes the statement that this prawn "is offered in the market there as a choice article of food, especially on Fridays and Sundays." From this one may infer that it serves equally well for fasting and feasting. Shrimps also have their grades and distinctions. It would be unmannerly to confound the common shrimp, *Crangon vulgaris*, with *Sclerocrangon boreas*, an Arctic species of noble proportions and prominent armour. They have in common the first pair of legs subchelate, that is, as before explained, with the finger closing down upon the palm margin of the hand instead of closing against an opposable thumb. But in spite of this obvious sign of near relationship the *Sclerocrangon* may disdain the shrimp of commerce on account of its own superiority in size and strength and armature. On the other hand, to humble its pride, we learn from Kröyer that when his party at Spitzbergen, in 1838, found it so abundant that they began to use it for food, in consequence of a specially rank flavour it met with no approbation.

On the crayfishes and their distribution over the fresh waters of the world, let the writings of Erichsen and Huxley and Hagen and Faxon be consulted. Then a man will know where to go for the large or the small sorts, and having ascertained the branchial formula and the true name of each, he will be able to eat with a good conscience and a well ordered mind. Nay more, he will be able to supply the information about which those authors have not been sufficiently thorough, as to whether the most enjoyable repasts can be made of *Cambarus* or *Potamobius*, of *Cheraps* or *Engaeus*, of *Astacoide* or another. For the last named he must go to Madagascar. *Cheraps* he will find in New Holland. He can dig for *Engaeus* in Tasmania.

Of lobster-like animals in Great Britain, we eat the river crayfish, the common lobster, the Norway lobster, and the rock lobster or crawfish. The last of these differs very obviously from the first three by the great size and stiffness of its second antennæ, and by the comparative feebleness of its first legs which do not form nippers or chelipeds. Among the other three, which all and severally have three pairs of chelipeds, the graceful Norway lobster is easily distinguished by the much ridged and denticulate character of its long and slender front pair. A correspondent tells me that this crustacean is sold in Edinburgh at a shilling a dozen, and that he has seen the shores of the Firth of Forth strewn with them after a storm. As to the common lobster and the crayfish, in addition to the great difference in size and to the fact that one lives in salt water and the other in fresh, there are distinctions easy to observe in the rostrum and the second antennæ. In the latter, the exopod or outer branch attached to the second joint is proportionally much larger in the crayfish than it is in the lobster. Huxley, after explaining minutely the structure of the crayfish, especially recommends the student to compare a lobster with it in the various points which he has been discussing. So far as most of the points are concerned the student may eat both crayfish and lobster before commencing the comparison. He will pass with an increase of zest from the meat to the mechanism. Should he still need encouragement, he may have recourse to Dr. Herrick's valuable work on the American lobster. Not only is that a cousin-german to our own, but specimens of it are sometimes delivered alive in the markets of London and Paris. The New World may well have a few to spare, since, according to Herrick, "about three million lobsters are said to be taken in the British Isles in the course of a year, while the total number captured on the North Atlantic coasts of America has undoubtedly in some years reached close to one hundred millions." Though, however, the true

lobsters are so prolific in individuals, they are content with an exceedingly modest number of genera and species. In this respect they differ from the crayfishes and the crawfishes which have many of both. Of the crawfishes several are very handsomely coloured, of large size, extensively distributed, and very numerous. One well-known species, *Jasus lalandii* (Lamarck), is said to afford abundant food for the poorer classes at the Cape of Good Hope, besides keeping a factory at work for tinning and exporting it. Including the antennæ it is generally about three feet long and it is sometimes longer.

Hermit crabs do not look as if they could ever be inviting diet, yet an aberrant member of the group, the *Birgus latro* or Cocoanut crab, is a celebrated dainty.

Of the common crab it is needless to sing the praises. Rather is it to be lamented that no enterprising person will try to acclimatise amongst us, in favoured situations such as Cornwall or the Isle of Wight, the river-crab of the Continent, *Potamon fluviatilis*, said to be a tempting delicacy. The not less admired land crabs of the West Indies might not take kindly to our wilful temperature, and must be content to be eaten in their native haunts. The large spider-crab, *Maia squinado*, sometimes very plentiful in the South of England, is eaten apparently, as some jokes are laughed at, only out of compassion. The poor creature is perhaps maligned by a misnomer, for when Mr. Thomas Bell, the carcinologist, asked a little girl, who had some ready cooked for sale, whether they ate those crabs, she replied, "They ben't crabs, sir, them's spiders." Concerning another member of this family, Tilesius, in 1812, relates that it occurred very plentifully in Kamtchatka in a bay deriving its name from the abundance of the crabs, and that "the sailors of the Niva eagerly sought after the species, finding it to be very delicious as food." But on this point, as on one or two others, mankind speak not all with one mouth. In the United States of America the blue crab, *Callinectes hastatus*, is the common edible crab, and it is most esteemed just after exuviation, in what is known as the soft-shelled condition. It has recently received the alternative name of *sapidus*, the tasty one. *Lupa pelagica*, prized among us as a specimen for its striking form and beautiful colouring, is the common edible crab of Sydney in Australia.

Without further exemplification, then, it is evident that the generous globe in every zone, from sea or river or land, offers man some delectable crustacea to embellish his meals. Some of them may not be suited for our food. Some of us may not have gastric arrangements suited for feeding on them. But in being generally wholesome and generally palatable, few large groups either of animals or vegetables surpass the crustacea, and, in any case, they eat up things that we do not want, and are eaten up by things that we do, thus by a happy transmutation of species supplying blubber to the starving Eskimo, sealskin to the luxurious European, and all sorts of fish to all sorts of people all over the world.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

S. S. CYGNI.

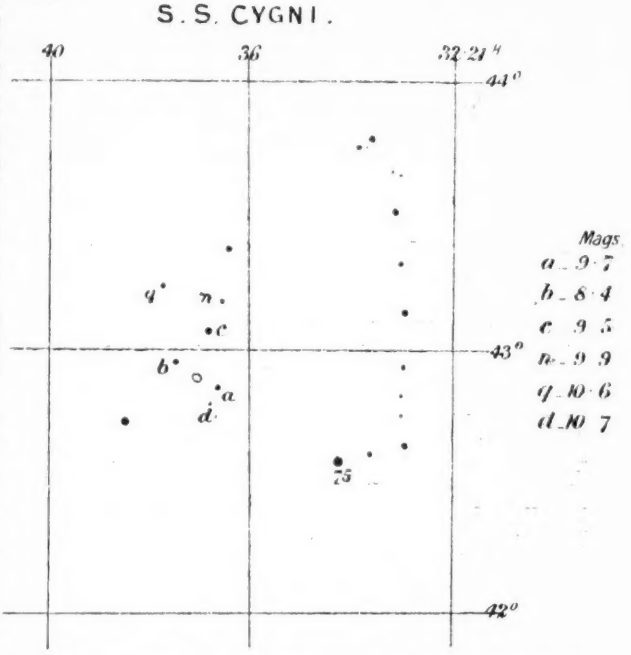
To the Editors of KNOWLEDGE.

Sir,—As Dr. Hartwig, at the last European Conference, called attention to the variable star S. S. Cygni, which seems to be designated as R^3 in "The Companion to the Observatory," the following ephemerides may be of interest to your readers. Its period is irregular.

1898.		Mag.
July 19	(invisible)	
,, 20	...	8·75
,, 22	(maximum)	8·25
,, 23	...	8·25
,, 24	...	8·55
,, 25	...	8·90
,, 27	...	10·05
,, 28	(invisible)	
Sep. 5	...	8·41
,, 7	...	8·31
,, 8	...	8·14
,, 9	...	8·18
,, 13	(maximum)	8·13
,, 14	...	8·13
,, 15	...	8·23
,, 17	...	8·95
,, 18	...	9·67
Nov. 10	(cloudy)	
,, 11	...	8·35
,, 12	(cloudy)	
,, 13	...	8·4
,, 13	(later maximum)	8·25
,, 14	...	8·35
,, 15	(cloudy)	
,, 16	...	9·35
,, 17	...	9·50
,, 18	...	9·95

1898.		Mag.
Nov. 19	(invisible)	
1899.		
Jan. 6	(7.30 p.m., invisible)	
,, 6	(8.00 p.m., very faint)	
,, 6	(8.40 ,, less than	10·00
,, 7	...	8·65
,, 8	...	8·35
,, 10	(about maximum)	
	Bad weather till	
,, 14	...	8·35
,, 16	...	8·8
Mar. 13	...	8·7
Maximum	three or four days earlier.	
July 1	(invisible)	
,, 2	...	8·30
,, 3	...	8·30
,, 4	(cloudy)	
,, 5	...	8·40
,, 6	...	8·35
,, 7	(cloudy)	
,, 8	(maximum)	8·20
,, 9	...	8·52
,, 10	...	8·75
,, 11	...	9·60
,, 12	(barely visible)	10·20

These are the means of several observations the same night.



My observations of U. Orionis at its last appearance are as follows:—

1899.		Mag.
Jan. 29	...	9·00
,, 31	...	8·7
Feb. 1	...	8·6
,, 7	...	8·3
,, 8	...	8·2
,, 23, 26	...	7·5
,, 27, 28	...	7·45
Mar. 28	...	6·65
,, 29, 30	...	6·60
Apr. 1	(maximum)	6·60
,, 2, 4, 7	...	6·60
,, 8	...	6·5
,, 9, 10, 11	...	6·7

1899.		Mag.
Apr. 12	...	6·8
Mar. 2	...	7·85
,, 3	...	7·7
,, 6	...	7·5
,, 7, 8	...	7·25
,, 9	...	7·30
,, 10	...	7·2
,, 11, 12	...	7·35
,, 15, 16	...	7·00
,, 19	...	6·95
,, 21	...	6·4
,, 22	...	6·45
Apr. 13	...	6·9

1899.	Mag.	1899.	Mag.
Apr. 15 ...	6·8	Apr. 30 ...	7·65
„ 16, 17 ...	6·7	May 7 ...	7·60
„ 18, 20 ...	6·8	„ 8, 9 ...	7·75
„ 23 ...	7·15	„ 10 (lost behind trees).	
„ 25, 26 ...	7·4		

The weather in the second and third weeks of February, aided by the moon, made observations and estimates difficult and unsatisfactory.

Memphis, Tenn., U.S.A., 29th June, 1899. David Flanery.

THE DISTRIBUTION OF STARS IN SPACE.

To the Editors of Knowledge.

Sirs,—With reference to Mr. Gore's letter in your issue for August, I quite agree with his remarks about the Milky Way. It appears to me very improbable that the galactic stars are of the same order of brightness as our sun. There can be no reasonable doubt that many stars of the 6th magnitude, and even brighter, belong to the system of stars composing the Milky Way. I believe very few astronomers now consider it likely that there is any great difference in the distance of the stars in this system; but if stars of the 6th and 16th magnitude are at the same distance, the 6th magnitude stars must be ten thousand times as bright as the 16th magnitude stars. With equal intrinsic superficial luminosity, this implies a difference of volume of a million to one; if, therefore, we assume the 16th magnitude stars in the Milky Way to equal our sun in size, it follows that the 6th magnitude stars in the Milky Way must be a million times as great. If it is considered, that, of the stars concerning whose mass we knew something, none is more than forty times the mass of our sun, it must be admitted that the existence of stars of a million times the size is very improbable. It is far more likely that the brighter stars in the Milky Way are of the same order of brightness as our sun, and that the fainter stars are much smaller.

The following table gives the results of some of my own gaugings in the region of the Milky Way compared with similar gaugings in other parts of the heavens:—

Aperture.	Number of stars visible. ¾-in.	Number of additional stars visible with each increase of aperture. 1¼-in.	2¼-in.	3-in.	3¾-in.
Sum of 22 gaugings in various parts of the Milky Way ...	61	174	301	306	198
Sum of 100 gaugings in various parts of the heavens, excluding the Milky Way ...	118	348	457	559	342
Relative density of the stars in the Milky Way.....	3·8	3·6	4·8	4·0	4·2

In taking gaugings in the Milky Way, I found it impracticable to use a field of the same area as in other cases, owing to the large number of stars to be counted. The area of the field was about ·625 of the area used in the one hundred gaugings of the stars generally, and this difference of area has to be taken into consideration in making a comparison of the results. The last line of the above table shows that the Milky Way, as far as these observations go, is about four times as rich in stars as other parts of the heavens. It will be noted that the increase in density is distributed among stars of various magnitudes, with some approach to uniformity. This fact certainly suggests the conclusion that galactic stars are at about the same distance as other stars.

One result of my investigations in this subject is a conviction that the assumption frequently made of the magnitude of a star depending chiefly on its distance is not justified by facts. My belief is that real difference in actual brightness, and not difference in distance, is the more important element in determining the apparent magnitude of a star. Gavin J. Burns, B.Sc.

[In other words, the *range* in actual brightness is greater than the square of the *range* in distance. The conclusion is one of great importance, but I think Mr. Burns is justified by the facts which he has adduced, and by the general trend of discovery, in adopting it.—E. Walter Maunder.]

SOME SUSPECTED VARIABLE STARS.

To the Editors of Knowledge.

Sirs,—In his paper on this subject, Mr. Gore does not appear to have considered the effect of "personal equation" in colour between different observers. In the case of β Leonis (p. 176), a bluish star, being compared with γ, which is yellow, the difference of colour will affect their apparent relative brightness. The Harvard observers made yellow stars distinctly brighter, relatively, than I do, and it is probable that the difference is even greater between them and Mr. Gore.

There is also the question, which has recently been so much discussed, of "position angle" to be considered and allowed for; the correction being probably variable for different observers. Therefore it seems to me hardly correct to say that if γ Leonis be seen distinctly brighter than β, that is certain proof of the variability of one of them.

I do not, however, on the whole, dispute Mr. Gore's conclusion; to me the relative brightness of the two stars undoubtedly varies, sometimes one and sometimes the other being the brighter, though it is difficult to decide which is the variable.

Sunderland, September 16th, 1899. T. W. Backhouse.

TREE STRUCK BY LIGHTNING.

To the Editors of Knowledge.

Sirs,—One of your readers, in a letter subscribed "A. C." (Knowledge, January, 1899), desires to have an answer to the question: "What actually takes place when a tree is struck by lightning?"

This certainly is a question of general interest, and I have had the occasion to observe the effects of lightning several times in different countries. Before all, I must say that the result of a lightning-stroke on a tree may be of very different character, and depends firstly on the species to which the tree belongs, and secondly, on the condition in which the tree is at the time it is struck.

If lightning strikes a tree after a long period of heavy rain, when the whole surface of the tree is damp, it generally does very little harm to the tree, and often none at all. On the other hand, if a tree is struck when its surface is dry, it is more severely damaged, because then the electric spark will descend by a line of lower resistance along the damp wood under the bark of the tree. In this case the heat of the spark instantly produces steam of very high pressure under the bark, and the latter is generally blown up in a long band.

In such cases, pine trees, and other trees of that kind, are much less damaged than other trees, because the wood of the pine is much more dry, and contains a greater percentage of isolating resin. In a leaf-tree there is no isolating substance, and if the whole interior of the tree is damp, it often happens that a large quantity of steam is produced,

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and thus the tree is quite destroyed by the lightning. A very old tree with a hole in its interior, if very dry, can even be set on fire by lightning, and burned down.

In all these cases it is certainly always water-steam of a very high pressure which is the principal cause of the destruction.

An interesting proof of the correctness of this explanation was afforded by the destruction by lightning of a monumental column in Gatchina, one of our Imperial summer residences, fifty kilomètres south of St. Petersburg. From the beginning of this century there stood a column nearly fifteen mètres high, named the "Connetable." It was of stone, and contained in its interior a series of iron angles, which held together the stones. After a period of rainy weather, it seems that much water had got among the stones into the interior of the monument. Then lightning struck it, killing the sentry on guard, and in the same moment the whole column disappeared from its place, blown up as by an explosion. Its fragments were thrown around in all directions, and some of them were found at a distance of more than one hundred and fifty paces. The column was completely destroyed, and only the pedestal, nearly three or four mètres high, remained. In this extraordinary case there is no doubt that the lightning spark, retained by the intervals between the iron angles, instantly produced a great quantity of steam of very high pressure in the interior of the damp column, and the latter was actually blown up by its explosion.

In the year 1896 I saw a very curious case in Lapland, where the lightning had struck a *Pinus sylvestris*. In this tree the fibres of the wood form a spiral around the trunk. The spark had taken the same direction, and had blown up the bark on the corresponding spiral line.

Baron N. Kaulbars
(*Lieutenant-General, Member of the Military Scientific Committee*).

St. Petersburg,
August 26th, 1899.

MEMORY WITHOUT REASON.

To the Editors of Knowledge.

Sirs,—Case 1.—A cart mare, kept for breeding but used for farm work when not maternally employed, was for several years turned into a grass field with her foal for the summer. In this grass field was an elm tree, with a low spreading branch on a level with the mare's back, and, much to the gratification of herself and to the amusement of the lookers on, the mare contracted a habit of standing in a certain spot transversely to the bough, and swaying herself backwards and forwards, thus getting an agreeable scratch-back, apparently in a rational manner. During one winter the bough was cut off in the absence of the mare, but when she was turned into the field again after some six months, I was surprised and amused to see her for some days separately, at intervals, stand in the old spot with the same backward and forward sway, without any apparent reason and without any satisfactory result.

Case 2.—A cart mare, with a foal loose in a grass field, got out of her depth in mud in a pond, and had to be dragged out in a very mired condition, with the characteristic pond-mud smell. Another mare that had been lying with the bedraggled mare all the summer, on getting the wind of her, became frantically excited, and was with difficulty kept away by four men and the bedraggled mare's heels, which were very active. Other mares in the same field and within scent took no notice. The explanation is that the frantic mare's foal had died about a month before, and a few days before its death it had been stuck in the same pond and had been dragged out, carrying the same smell. I have no doubt that the bereaved dam, deceived by the smell and perhaps partly by the circumstances being the same, thought (?) that her foal had again come out of the pond, and the sight of the mare, some sixteen hands high, could not persuade her to the contrary.

These two cases go to show how little horses depend on sight, or use their eyes, as compared with ourselves.

Kitchen End, Hampshire, C. Crouch.
Sept. 3rd, 1899.

Obituary.

On the first of August there passed away, at Great Cotes, Lincolnshire, in the person of John Cordeaux, one of the best types of the field naturalist. By ornithologists, especially, his loss will be keenly felt. For many years Cordeaux was a regular contributor to the ornithological columns of the *Field*, the *Zoologist*, the *Naturalist*, and many other natural history journals, as our own pages will testify. It was chiefly in connection with the migrations of British birds that his name as an ardent worker, as well as an authority on the subject, will be best known. John Cordeaux was the chief instigator of the formation, in 1880, of a committee of the British Association which held such an elaborate and exhaustive investigation into the subject of bird migration as observed on the coasts of Great Britain and Ireland. For nearly twenty years Cordeaux carried out the arduous duties of secretary to this committee, which did such valuable work. In 1878 he published a volume on "The Birds of the Humber District," while just before his death he issued "A List of Birds belonging to the Humber District." In this last work the information regarding the birds of his district is brought down to date, and the list contains the extraordinary number of three hundred and twenty-two species. He was a well-known member of the British Ornithological Union, president of the Yorkshire Naturalists' Union, and first president of the Lincolnshire Naturalists' Union. But he was not only an ornithologist, he had a considerable knowledge of botany and general zoology. To those who knew him, John Cordeaux will be remembered as a kind and courteous gentleman, a true and warm-hearted friend, always ready to impart information, always keen to seek the truth.

Science Notes.

Persons interested in the forthcoming total solar eclipse of May 28th, 1900, will be glad to learn that great care and forethought are being exercised by some of our leading astronomers in the necessary preliminaries for ensuring success, as far as is practicable, in the manifold problems which present themselves for solution in such expeditions. The path of the moon's shadow in the Eastern Hemisphere reaches from Oporto to Algiers, and the duration of totality ranges from 1m. 36s. in Portugal to 1m. 6s. in Northern Africa. The sphere of activity will be mainly in places between 8° longitude E. and W. of Greenwich, and latitudes 35° N. to 42° N., thus affording an exceptional opportunity of easy access at a moderate cost to those who wish to visit the scene of operations. It is urged that Algiers should be occupied on account of its low cloud ratio, its accessibility, and its excellent harbour; in the region south of Madrid several railway lines cut the shadow track, so that the difficulty of transporting instruments will thus be minimised; some inconvenience, how-

ever, may be caused by the slowness of the trains, which run about fifteen miles an hour, and the long intervals between them, there being in most parts only two a day, and only about one an hour out of even Lisbon. Mr. Maunder has been very active in bringing useful information together for the benefit of those taking part in the expedition, and in this connexion the following particulars may be helpful :—To Lisbon (or Oporto) and back, £10; to Cadiz, giving access to the centre of Spain, and back, £14; to Alicante, a port on the east of Spain, where the eclipse will be visible, £16. Algiers is the final place to which the steamer will proceed, and remain there to act as an hotel for the party. The cost for the entire trip for those going to Algiers and remaining on board during the stay at Algiers would be £22 10s. These figures represent the cost to members of the British Astronomical Association. To friends the charge will be guineas instead of pounds. The eclipse committee ought to know definitely before the end of the year the exact number of passengers going and the ports which they may have selected, in order to be able to complete arrangements. As yet one hundred and fourteen or one hundred and fifteen names have been given in; but in order to justify the committee in completing the arrangements they ought to have at least two hundred taking part in the expedition. The entire trip will take eighteen days.

Mr. E. E. Austen, of the Zoological Department of the British Museum, has accompanied the expedition from the Liverpool School of Tropical Diseases to Sierra Leone in the capacity of naturalist. Though his special work is upon Diptera, and no doubt he will make a particular point of those insects which convey diseases, yet Mr. Austen will be able to do some more good general work on the lines of that he compassed during his trip up the River Amazon a little time back.

Anyone wishing to see the extent to which the Röntgen rays have influenced scientific instrument making will be repaid by a visit to the works of Messrs. Isenthal, Potzler & Co. All the latest additions to the radiographer's outfit and demonstrations of the wonderful effects achieved therewith are freely exhibited by these ingenious contrivers of apparatus for all kinds of work in this special line.

British Ornithological Notes.

Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.

Notes on the Razorbill. By Edward M'Canon (*Irish Naturalist*, June, 1899, pp. 132-136). Mr. M'Canon, one of the Irish light-keepers, gives some interesting and original notes on the Razorbill, especially as regards the different plumages of the bird.

White Wagtails at Bartragh, Co. Mayo (Irish Naturalist, August, 1899, p. 187). Mr. Robert Warren records that Mr. Kirkwood again saw White Wagtails this spring on the island of Bartragh for the third year in succession, on their northern migration. From this it would seem that White Wagtails are in the habit of migrating along the west coast of Ireland in the spring, probably on their way to Iceland, and possibly Greenland, in both of which countries they breed.

The Construction of the Nest of the Little Tern (Sterna minuta). By Charles J. Patten, B.A., M.D. (*Irish Naturalist*, September, 1899, pp. 189-197). A very careful and detailed description is given here of the construction of Little Terns' nests found during several years at two colonies near Dublin city. Dr. Patten describes the "nests" as rather elaborately constructed hollows, lined with shells. These "nests" were made in shingle-covered sand, and Dr. Patten remarked that round the eggs was a narrow zone of bare sand. It must not be thought from this that all Lesser Terns' "nests" are constructed in the same way. We have found the eggs of these birds on the Kentish coast placed on the bare shingle, without even a depression, or apparently the disturbance of a stone, and we have found them in the Spanish *marismas* in the merest "scoop" on the bare, hard mud.

Blue-headed Wagtail in Cumberland (Zoologist, June, 1899, p. 267). The Rev. H. A. Macpherson says that after waiting for seventeen years he has at last detected *Motacilla flava* in Lakeland. He identified and watched a specimen of this bird for two hours on May 1st last, near Maryport, Cumberland. This Wagtail is very common in many parts of the Continent, but it can only be considered as an occasional migrant in Great Britain.

On some Remains of Birds from the Lake-dwellings of Glastonbury, Somersetshire. By C. W. Andrews, B.Sc., F.Z.S. (*Ibis*, June, 1899, pp. 351-358). Mr. Andrews gives details of a number of bird bones found in the Lake-dwellings discovered in 1892 at Glastonbury. The author concludes that the birds were killed with the sling, and used as food by the inhabitants of the ancient pile-dwellings.

Report on the Movements and Occurrence of Birds in Scotland during 1898. By T. G. Laidlaw, M.B.O.U. (*Annals of Scottish Natural History*, July, 1899, pp. 140-158). This is a detailed and comprehensive record of bird movements in Scotland. Mr. Laidlaw's report, drawn from records furnished by some forty observers in different parts of the country, should prove of great value to Scottish ornithologists.

All contributions to the column, either in the way of notes or photographs, should be forwarded to* Harry F. Witherby, *at 1, Eliot Place, Blackheath, Kent.

Notices of Books.

Man; Past and Present. By A. K. Keane, F.R.G.S. (Cambridge University Press.) In fulfilment of his promise, the author of the volume on "Ethnology," which has proved so successful, has supplemented that work by the present treatise, which deals in greater detail and more systematically with the primary divisions of mankind. Since the appearance, in 1874, of the English translation of Oscar Peschel's "Races of Man," there has been no such convenient text-book published as that now before us. The production of a volume like this involves the possession of a combination of qualities such as few can lay claim to. Happily, Mr. Keane's well-known linguistic powers, together with a general acquaintance with the details of physical anthropology and an intimate knowledge of the vast literature of the subject, have been the means of enabling him to impress upon this work, which must of necessity be largely a compilation of the observations of others, his own personality. The plan of the book is excellent. The first two chapters are devoted to the discussion of certain general considerations. In these we notice the author's adherence to such expressions as the "old stone age" and the "new stone age" as applied to chronological periods; more properly they apply to stages of culture. We cannot but think that such abuse of the terms leads to much confusion. We speak of a neolithic period as if it were a past age. So it is, so far as we are concerned, but it may be pointed out that there are still many savage races living in a stage of neolithic culture. Furthermore, we lay far too great stress on the transition from the palæolithic to the neolithic stage of culture, forgetful of the fact that in the production of a neolithic implement it must first pass through the palæolithic stage of production; hence it may be that many of the roughly-trimmed flints found with polished tools or weapons are but the specimens cast aside by the maker before he succeeded in obtaining one suitable to receive a better finish. The labour involved in chipping a rude flint is not great, hence the implement made may often have been thrown away after having been used; on the other hand, the time and labour expended in the production of a polished implement rendered it an object of value to the owner, and doubtless, in many instances, it was handed down from generation to generation. Much, too, depends on the material employed, the more highly prized examples being always those most difficult to work. From the culture standpoint, a stone age in nowise differs from a bone age, though the remains of the latter are scarcer owing to their perishable nature. The succeeding chapters are devoted to a consideration of the various races of mankind; each is preceded by a conspectus in which are briefly summarised the facts relating to the primeval home, present range of distribution, physical characters, temperament, speech, religion, culture, and main divisions of

each group. In dealing with the four great divisions of mankind, the author discards the use of the term Aryan, and adopts instead that of Caucasic. As he points out, "Aryan" is a linguistic expression forced by the philologists into the domain of ethnology, and the Aryan prototype has vanished as completely as the Aryan mother tongue. The term Caucasic, as used by him, is a symbol to denote those peoples in whom we recognize "a common racial stamp on the facial expression, the structure of the hair, partly, also, in the bodily proportions, in all of which they agree more with each other than with the other main divisions," and in no way implies that they originated in the region of the Caucasus. In regard to the question of origin, whilst admitting that no final answer can yet be given, he supports the view that Africa north of the Sudan was probably the cradle-land of this vast race. Upholding in many respects the views of Sergi, in regard to the diffusion of the Mediterranean races, he succeeds in shedding additional light on the identity of the language of the Basques and Berbers. In his account of the characteristic appearances of the eye, the author, in several instances, falls into error. Thus, in describing the eyes of the Sudanese and Oceanic negroes, he states that they have a yellowish or dirty-yellowish cornea. Now the cornea is the transparent medium through which the colour of the iris is visible. The "white of the eye," to which he undoubtedly refers, is the sclerotic overlain by the conjunctiva. This is a minor detail no doubt, but in such a work accuracy is essential. Whilst our existing state of knowledge is such as to preclude the settlement of many of the vexed questions involved in racial affinities and migrations, and whilst we cannot in all respects agree with the author's conclusions, yet we are bound to say that he has stated his case clearly, and has laid the student of anthropology under a deep debt of gratitude. We venture to predict a great success for this the latest addition to the Cambridge Geographical Series.

A Russian Province of the North. By Alexander Platonovich Engelhardt. Translated from the Russian by Henry Cooke. (Constable.) Illustrated. 15s. The Province of Archangel, which is that dealt with in this book, is an exceedingly large one, embracing the whole of the northern seaboard of European Russia, a country about which little is known by the general public, and into which comparatively few Englishmen have penetrated. The author, the Governor of this Province, is a man of distinctly progressive ideas, which he has the energy and the resource not only to plan but to carry out; but our author is an official, and in this book betrays the presence of those rose-coloured spectacles through which an official in his own Province must see or seem to see many things. Bearing this in mind, and the fact that the country visited was always prepared for the advent of a high official, and he a Russian, the book will be found to be very instructive and in many parts entertaining reading. It contains many interesting statistics, especially regarding the fisheries of the Arctic Ocean, as well as a certain amount of light history and some airy tales, without which no book of travel is complete. The most important matter dealt with is without doubt the development of the northern coast of the Kola Peninsula, and the establishing of the new port of Ekaterina, which was officially opened only last July. This is in reality the only Russian port which is ice-free the whole year round. The harbour is a good one, but too small to make the place of any importance from a naval point of view. Whether there is enough trade to justify the very large amount of money that has been spent upon the new "town" and harbour itself is not for us to judge, but if in years to come a railway is run through the Kola Peninsula straight to St. Petersburg, Ekaterina will no doubt be a place of some importance commercially. For this reason it is a great pity that no better site for it could be found than a land of rocky hills and mossy bogs. Naturalists will find little of interest in the book unless they intend visiting part of the country of which it treats, in which case we can heartily recommend it for its statistics and accurate detail as regards distances to be traversed and means of travelling.

Insects: their Structure and Life. A Primer of Entomology. By George H. Carpenter, B.Sc.(Lond.). (J. M. Dent & Co.) In the compilation of his very complete introduction to a fascinating study, Mr. Carpenter has made full use of the standard works of Prof. Packard and Dr. Sharp; and the list of upwards of two hundred authorities quoted in the valuable bibliography which forms an appendix to the volume, shows that his desire for accuracy has made him neglect the question of trouble altogether. Several of the well-chosen illustrations which the author has reproduced from Bulletins of the Division of Entomology of the United States Department of Agriculture, accentuate in a very decided manner the good work done by the very liberal distribution which that Department makes of the numerous monographs prepared by the officers in its various divisions. Mr. Carpenter's experience in the Dublin Museum of Science and Art, and his work for the Royal Dublin Society, have served him in good stead, and the consequence is that the beginner will here find an elementary account of the chief characteristics of insect life and habits which is altogether trustworthy.

Rambles with Nature Students. By Mrs. Brightwen, F.E.S. (Religious Tract Society.) Illustrated. 5s. Young people just beginning to take an intelligent interest in stones, mosses, insects, birds, and the thousand-and-one things which, taken in the aggregate, lend such inexhaustible charm to outdoor life, will find in Mrs. Brightwen's "Rambles with Nature Students" a most helpful companion and guide—a sort of mental microscope enabling them to discern beauties and varieties in the objects to be met with everywhere in the country. The book is divided into twelve parts, each part being assigned to one of the months of the year, and so the student who begins his studies with the aid of this charming little auxiliary need not wait for any particular season, but is provided with mental food ready to hand everywhere. Just such objects are selected for January and the rest of the months as are available and convenient for description at the time. The volume is handsomely bound, well printed, and tastefully illustrated, and, as such, is very suitable as a prize for young boys and girls in elementary schools.

The Hunterian Oration, 1899. By Sir William MacCormac. (Smith, Elder & Co.) 2s. 6d. Hunter was celebrated alike as a great surgeon, a profound biologist, and a man of genius. One way of keeping him in memory is by means of the Hunterian Oration, delivered in the Theatre of the Royal College of Surgeons, in alternate years, on the 14th February—Hunter's birthday. This year's oration contains only a slight biographical sketch, Sir William dwelling more in detail on the great surgeon's never-to-be-forgotten work on aneurism, venereal diseases, animal heat, gun-shot wounds, and inflammation, and it is remarkable how little has been done during the last hundred years, in certain directions, by way of improvement on the surgical operations initiated by Hunter. The oration is reproduced in large type, wide margins, and handsome cover, and thus forms a pleasing medium for acquiring readily a knowledge of the main facts concerning a master of organic science.

BOOKS RECEIVED.

Darwin on Trial at the Old Bailey. By Democritus. (Universal Press, Limited, Watford.) 2s.

Elementary Practical Physics. By F. Castle. (Nelson.) Illustrated. 2s.

The Logic of Vegetarians. By H. S. Salt. (Ideal Publishing Union.) 1s.

The Teaching of Languages during the early period of a Deaf Child's School Life. By Lydia Roe. (Royal Institution for the Deaf, Derby.) 1s. 6d.

Rhymes of Road, Rail, and River. By E. Derby. (Arrowsmith.) 1.

Handbook for Canterbury. British Association, Dover, 1899. (*Observer* Office, Dover.)

A Glance at Current History. By John Cussons. (Cussons, May & Co.)

The History of the European Fauna. By R. F. Scharff. (Scott.) 6s.

Accentia: A System of Accented and Abbreviated Shorthand. By Armistead Cay. (Blackett, Bath.) 2s. 6d.

The Universal Illusion of Free Will and Criminal Responsibility. By A. Hamon. (Universal Press, Watford.) 3s. 6d.

Directory: Science and Art Department. Revised to July, 1899. (Eyre & Spottiswoode.) 6d.

Handbook: British Association, Dover, 1899. (*Standard* Office, Dover.)

The Pathology of Emotions. By Ch. Féré. Translated by Robt. Park, M.D. (Universal Press, Watford.) 15s.

Carvell's Nursery Handbook with Hints. (George Barber.) 1s.

Laboratory Manual. By H. W. Hillyer. (Macmillan.) Illustrated. 4s. net.

The Wheat Problem. By Sir Wm. Crookes. (Murray.) 2s. 6d.

Musical Pitch: Letters, &c., on the Proposal to Adopt the Low Pitch. (Waterlow & Sons.) 2s. 6d. net.

Archives of the Röntgen Ray. Vol. III., No. 4, and Vol. IV., No. 1. 4s. net.

Precession Tables adapted to Newcomb's Value of the Precessional Constant—Epoch 1910·0. By Dr. A. M. W. Downing. (Neill & Co., Edinburgh.)

The Studio: an Illustrated Magazine of Fine and Applied Art. September. 1s.

BEN NEVIS AND ITS OBSERVATORY.—II.

By William S. Bruce, F.R.S.G.S., *formerly in charge of the Observatory.*

(Illustrated by photographs taken by the Author.)

THE staff consists of three men, two observers and the cook who looks after the general comfort of the establishment and keeps the rooms in order. The observer in charge usually takes the night watch of eight or nine hours, from 8 p.m. till 4 or 5 a.m., then the second man is on duty for another eight or nine hours—*i.e.*, until noon or 1 p.m. During this latter time the night watchman sleeps, a fact not always realized, I am afraid, in summer by early visitors, who come up the mountain in the morning to see the sun rise, and often make a great noise, even getting on the flat roof of the Observatory and stamping vigorously to keep their feet warm, a proceeding which is promptly stopped by the day watchman. After dinner at 1 p.m., the afternoon is filled up by the shorter dog watches. By this means the observers not only record, but reduce, tabulate and average all the observations taken and put them into form for further investigation.

All the observations taken are eye observations, and this must necessarily be so for keeping a continuous record as will presently be explained. Every hour the observer goes the round. First of all the barometer, which is of the *Fortin* pattern, is read; for the next observation, it is

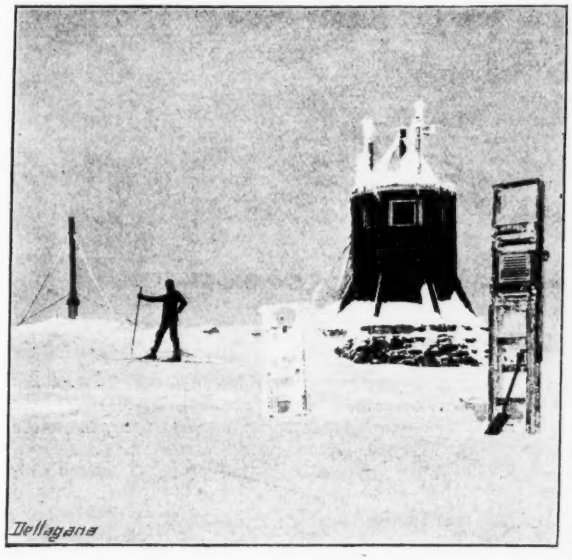


Fig. 3.—Observatory from South-East: Winter. All but Tower and Stevenson Screens buried under Snow.

necessary to go outside to some considerable distance from the building in order to read the dry and wet bulb thermometers, which are placed in an ordinary double louvred Stevenson screen. These two observations are always taken so as to exactly correspond with those being recorded by photography and clock-work at the Low Level Observatory in Fort William, and the remaining observations rapidly follow. The observer has carried out with him an empty rain gauge. This is changed for the one that has been out for the past hour, which is now covered up and taken back to the Observatory. Climbing up a ladder on to the roof of the Observatory, the observer faces as accurately as possible the wind, notes its exact direction and force (this is done with marvellous accuracy by an adept), immediately after he notes the velocity recorded by the anemometer, and thus his personal observation is checked. The clouds are next noted, whether they be *Upper* or *Lower*, and what species of upper or lower, and the percentage of the sky they cover above thirty degrees from the horizon. Is it raining at the time of observation? Is the sun shining clearly or gleaming through a cloud, or not at all? Are there clouds (or fog, as such clouds are called at Ben Nevis) below the summit, or are they passing over the summit? Are there glories, coronas, halos, fog-bows, rainbows, and such like, or is the summit enveloped in a cloud? Is that cloud in the form of mist (wet), or fog (dry)? Is it thick so that you cannot see more than five or ten yards ahead, or is it so thin that you can almost see the whole of the eleven acres of the summit of the Ben? Are there rifts in it, opening up a vista for a moment of some of the grandest of Scottish scenery, or is it tending to clear overhead, only hiding the blue sky with a thin veil? The direction in which the clouds are travelling, and whether they are travelling at a quick or a slow rate must be noted. Is there thunder or lightning; or do we hear the whole hill-top wildly hissing with Saint Elmo's fire at every point, if it be at night, gleaming with a living lurid flame? The tops of the chimney, anemometer, every post or pole, even the observer's fingers or pencil if he holds it up aloft, and perchance his hair, if he remove his cap, will hiss and blaze with dancing flames. It is a time when all but novices prefer to be below! Entering the tower door, and descending half-way down a ladder, he now steps into a little room, where, by means of an ingenious instrument invented by Mr. John Aitken, he counts with great exactness the number of dust particles per cubic centimetre of air—a very important branch of meteorological inquiry originated by Mr. Aitken. Then he descends, and enters the office, where he measures the amount of rain that has been collected in the rain gauge that he has just brought in with him. If there be snow in the gauge, then he has to melt it first. These are the regular hourly observations, but there are additional observations at certain hours. The maximum and minimum thermometers, which are read once a day; the black bulb thermometer in vacuo; the depth of the snow, if any, and so on.

After every set of observations the observer has some little time in the observatory before he gets ready to take the same series as those just described. During this time he is copying the observations he has made from the hourly slip on to larger "Daily Sheets," which hold all the observations taken for the whole day by the superintendent and assistant, and if it be on the night watch after midnight each set of the twenty-four hourly observations is added up and their mean taken. The maximum and minimum for the whole day of each of the twenty-four sets of observations is noted. During this time also he is keeping up in a similar way the "Monthly Record Sheets." These consist of separate sheets for rainfall, sunshine, temperature, wind, etc. Take barometric pressure, for instance, there are twenty-four columns in this sheet, and along the top line each

XUM

hour's observation is set down for the whole day. On the second line each hour's observation is again set down for the second day of the month, and for the thirty-one days of the month. In addition to the twenty-four records, the sums and means, and maxima and minima are also recorded in each line, then at the end of the month each of these columns is added up vertically and meaned. Thus at the foot of the page is the series of means for the same hour for every day during the whole month, and in the last vertical column are all the means for the whole day every day of the month. The mean for the whole month is obtained by taking the mean of either of these columns—namely the vertical or horizontal one; and by working both, there is an effective check upon any arithmetical or clerical error, which not unfrequently occurs, and often involves a great deal of labour to find out. By this means not only are the observations made, but are tabulated and prepared for further discussion.

As long as the weather is fine all this work is straightforward enough, but fine weather, it may be said, is exceptional on Ben Nevis. It has been said that in summer the climate of Ben Nevis may be regarded as much the same as that of Spitzbergen. I have spent the summer in Spitzbergen as well as on the summit of Ben Nevis, and I should say that there is more fine weather during that period in Spitzbergen than on our Ben. As for the rest of the year the weather on Ben Nevis is far from pleasant, and during bad weather the work of observing is not to be envied. The usual rule is that every hour the man on duty has to put on his oilskins and sea boots and face pelting rain or driving snow, and find his way through thick mist or fog to the thermometer screens, rain gauge, and other instruments, stationed some way from the house in order that they may not be affected by it in any way; all the night long he has to take out a lamp every hour, and if the wind is high the lamp may blow out. This frequently happens, in spite of very carefully constructed lamps, in which case he has to grope his way back to the house in the dark, and woe betide him if he go in the wrong direction, for close to the Observatory is the Great Cliff, which is sheer up and down for nearly two thousand feet! Digging and clearing the snow from the lower windows and door is, as I have said, another duty of the observers, although "for days at a time digging is rendered useless by the continual drifting of the snow"; then paraffin lamps have to be burnt by day as well as by night. During such weather as this the observers have to go out oftener than usual. Thermometer screens have to be cleared of drifted snow which chokes up their louvres, and thus prevents a clear circulation of air round the instruments. What is even worse, the fog throws an accretion of ice crystals upon everything; then the instruments are blocked up even more than by driving snow. Worse than fog crystals or snow, however, is when the condition known as "silver thaw" prevails, that is, rain falling when the air is below the freezing point and freezing as it falls, covering every object with a clear hard layer of ice. Especially on the latter occasions, as well as when fog crystals are forming and snow drifting, have the thermometer screens to be cleared, and when they get hopelessly blocked up, they simply have to be brought—screen, instruments and all—into the house to be thawed, and a new set put out. This is more easily effected by a special movable box, which is always used during the winter months, and is lashed on to a ladder-like stand. Besides being a useful arrangement for allowing the screens to be brought into the house to get cleared, it is also useful for changing the height of the box. Shade temperature observations should always be taken at a height of about four feet from the ground, and by this arrangement, as the winter snow increases in depth, the Stevenson screen can be raised accordingly, so that it shall always be the normal height above the surface of the ground, for the surface of the snow must be regarded as the surface of the ground during winter. "The vital importance of thermometric observations is emphasised by the circumstance that without them the barometric observations are of comparatively small value, no approximation to a knowledge of the temperature of the air-stratum between high and low level observatories being possible. Ben Nevis is the only observatory that has hitherto coped successfully with this all-important department of the work of a high-level observatory, and one cannot sufficiently admire the heroic endurance with which the observers have made the hourly observations by night and by day, in all seasons, these years past."

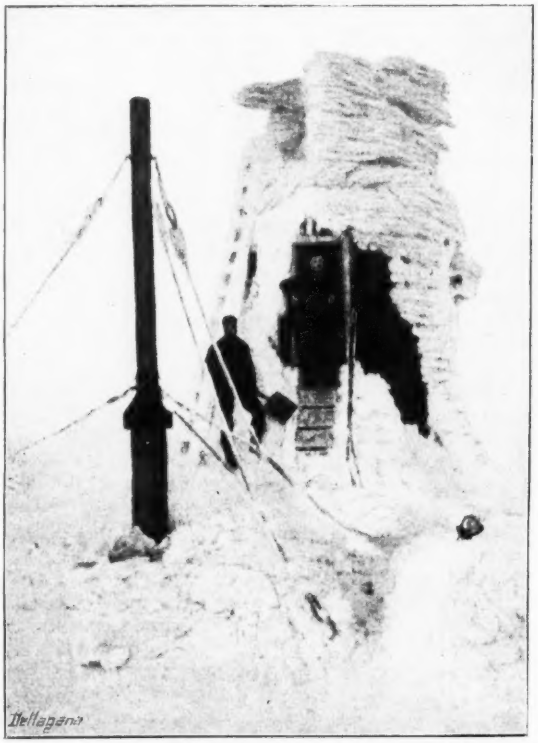


Fig. 4.—Fog Crystals covering Tower and Instruments: Winter.

In addition to the ordinary routine work of a "first-order meteorological observatory" a great deal of extra research work has been accomplished by volunteers and by members of the staff. Messrs. Omond and Rankin have made an exhaustive examination of the winds of Ben Nevis, which has been published in the *Transactions of the Royal Society of Edinburgh*. It is found that the Ben Nevis winds do not agree with the distribution of barometric pressure at sea level according to Buys Ballot's law of the winds in relation to pressure, but point to a widely different distribution of pressure at four thousand four hundred and seven feet as compared with the distribution at sea level. The effect of high winds on the height of the barometer is another of Dr. Buchan's investigations. In forecasting weather it is necessary to keep this effect constantly in mind, "with the view of arriving at a

better approximation to the geographical distribution of pressure at a time the forecasts are being framed."

An examination of the relationship of the differences between the temperature at the summit and at the Low-Level Observatory, and the differences of the reduced pressures at the two stations, shows that a relatively greater pressure exists on the summit as the temperature on the summit becomes as high or higher than that at the base. Recently this problem has been further worked at by having a third intermediate station half-way up the mountain. Observations of the rainband carried on since 1885 have given very valuable forecasting results. A decreasing rainband from hour to hour "appears to be the earliest indication we at present have that an anti-cyclone is beginning to form and settle over North-Western Europe." Mr. H. N. Dickson, and Mr. A. J. Herbertson more recently, have both carried on important hygrometric examinations of the atmosphere. The observations taken with Mr. John Aitken's dust-counting apparatus have added to our knowledge of the diurnal movements of the atmosphere and of existing cyclones or anti-cyclones.

To fully appreciate the very valuable work that has been and is being carried on at Ben Nevis Observatory, it is necessary to refer to the many reports that have appeared in the Transactions of the Royal Society of Edinburgh and of the Scottish Meteorological Society. Under the Secretaryship of Dr. Alexander Buchan and the Superintendentship of Mr. R. T. Omond, and more recently Mr. Angus Rankin, the Ben Nevis Observatories, both High and Low Level Stations, have added much to our knowledge of the general laws of meteorology. The institution, under the auspices of the Scottish Meteorological Society so far has been supported almost entirely by private contributions, and by many volunteer workers, and it is hoped that further support both in coin and kind will be forthcoming in order to enable the Scottish Meteorological Society to carry on the good work it has been doing for the last seventeen years. To us as the greatest seafaring nation in the world it is of the utmost importance that we should know all we can about our atmosphere, so as to be able to predict more certainly than we can at present many of the disastrous storms that sweep our coasts before we have time to give our seamen sufficient warning. We cannot but admire the excellent work that has been done by private efforts at the Ben Nevis Observatories, but surely our Government ought to take interest in a piece of work which is of such national importance!

SOME SUSPECTED VARIABLE STARS.—III.

By J. E. Gore, F.R.A.S.

THE stars included in the following paper look very suspicious, and seem deserving of further examination.

In his well-known *Bedford Catalogue*, Admiral Smyth says (p. 25), "Just 18′ south of μ Cassiopeiæ is a star which, though of the 6th magnitude, is not in Piazzi. It is followed nearly on the parallel, about 11s. off, by a 9th magnitude, and both are remarkable for being red, of a decided but not deep tint." There seems to be no star at present in Smyth's position, at least nothing approaching in brightness a star of the 6th magnitude. In *Nature*, October 21st, 1875, the following remarks occur with reference to Smyth's stars: "There is no star of the 6th magnitude near this position at the present time, nor, so far as we know, is there any record of such an object having been seen since the epoch of Smyth's observations, 1832–71. It may, however, prove to be a variable of a long period. . . . There is now a star of the 9th magnitude following μ Cassiopeiæ 17·2s. and 15′ 38″ south; this is clearly Argelander's star + 53°, No. 228 of the *Durchmusterung*, there estimated 9·5, a considerably fainter object than an average 9th magnitude in Bessel's scale; its place would appear to correspond better with that of Smyth's star, following his 6th magnitude nearly on the parallel, than with that of the missing star. Probably this small star may be variable also." The 6th magnitude star seen by Smyth may possibly have been a *Nova* or "temporary star." As several of these curious objects have been discovered in the past few years their occurrence may perhaps be more frequent than is generally supposed. A "new star" of the 6th or 7th magnitude might easily escape detection.

Birmingham II. 16 Leporis.—This red star was rated 7th magnitude by Piazzi, and 6½ by Lalande (9785). It is not given by Argelander or Heis, but was rated 6·0 at Cordoba. It was estimated 5th magnitude by Morton in 1856; 6 by Sadler in February, 1875; 6·5 by Winnecke, December, 1875; 6·0 by the present writer in January, 1877; 7·5 and 7·2 by Espin, in December, 1877, and January, 1878; 6·0 by Espin, December 17th, 1878, 6·7 January 5th, 1879, and 6·5 in December, 1879. Cornish found it 5·6 magnitude in January, 1880, and "fairly bright to naked eye." Espin rated it 5·8 in October, 1880; and Pickering made it 5·86 in December of the same year. Ward gave it 5·5 in January, 1883, and it was rated 6·0 by the present writer in February, 1885, and February, 1886. In Stone's *Southern Catalogue* it is 5·6 magnitude (1878-76). Flammarion says, "Elle est certainment variable." It precedes ε Leporis 55·24 seconds, and is 53·25″ to the north of it, and may easily be found with a binocular field glass.

σ Orionis.—The 11th magnitude star preceding the principal star of this group may possibly be variable. It escaped the keen eye of Sir William Herschel, but it was seen by Ward with a telescope of 2⅞ inches aperture; and the present writer found it plain enough with four inches in the Punjab in 1874. In March, 1883, the late Mr. Baxendell found it of unusual brightness.

Bayer shows a star of 6th magnitude 1° south of g Virginis. This was suspected to be variable by Pigott, who says: "This star is not in any of the nine catalogues. Maraldi looked for it in vain, and in May, 1785, I could not see the least appearance of it. It certainly was not of the 8th magnitude." The star may possibly be identical with either Lalande 24,283-4 (7½, 9½ magnitude), or Lalande 24,393 (7½ magnitude). The latter answers better to Bayer's description, but the position of the former agrees more closely with the place given by Pigott (R.A. 12h. 53m., S. 10° 0′ for 1786).

A star about 40′ south following 53 Virginis was suspected by Olbers in 1797 to be a remarkable variable. He found it the brightest star in the immediate vicinity of 53 Virginis. In July and August, 1876, Tebbutt, at Windsor, N.S.W., estimated it 8½ magnitude. On May 10th and 11th, 1876, it was rated 9 magnitude by the present writer, equal to Olber's star c, but brighter than Olber's star d (see *Nature*, April 13th, 1876).

In Heis' Catalogue of Stars visible to the naked eye in the Northern Hemisphere, his No. 67 of the constellation Draco is rated 6-7 magnitude, and identified with No. 1801 of Argelander's *Catalogue of Stars* between − 2° and + 90° declination. The present writer found this star only 8½ magnitude on November 24th, 1878, and April 8th, 1883. It lies a few minutes *following* B.A.C. 5248. If it was ever visible to the naked eye it must certainly be variable. It is not in Argelander's *Uranometria*.

XUM

σ Coronæ.—A small star following this binary (51″, 1862) was rated only 15 or 20 magnitude by South in 1825, but "more like 10 magnitude" by Franks in 1876. I have seen this small star well with a 3-inch refractor in the Punjab sky.

In 1862, Tebbutt, while observing Comet III. of that year, noticed a star of 5th magnitude about "a degree north-east" of σ Aræ. Both stars were visible to the naked eye, the supposed variable being the brighter of the two. On examining the place of the star with a 4½-inch reflector on November 13th, 1877, Tebbutt only found stars of the 10th and 11th magnitudes near the spot. One faint star particularly attracted his attention, and its position agreed fairly well with that of the 5th magnitude star observed in 1862. There are some other faint stars near the place. As Tebbutt's 5th magnitude star lay in the Milky Way, it was probably a *Nova*, or "temporary star."

A star close to the *Durchmusterung* star, 17°, 3997, was rated 6, 6, and 6·5 magnitude by d'Agelet on July 26th, 27th, and 29th, 1783, but is not given by Lalande or Harding. In 1882 and 1883, Dr. Chandler failed to see any trace of a star in d'Agelet's position with a 6¼-inch reflector, and found it invisible with 15-inch refractor, November 14th, 1883. On September 18th, 1884, the present writer could see no trace of the star with a binocular in a clear sky. Have we here another *Nova?*

About 2½° *south preceding* σ Capricorni, Sir John Herschel observed a red star, which he rated 6½ magnitude, and says, "A fine ruby star. This is perhaps the finest of my ruby stars." I failed to see this star with an opera glass in July, 1875, and with 3-inch refractor found it only 8½ or 9 magnitude, and fiery red. In November, 1876, and August, 1879, I found it about the same magnitude. If Herschel's estimate of 6½ magnitude was at all correct, the star must certainly be variable. Closely following, a little north, is a fainter star about 10 or 10½ magnitude. Variation was also suspected by Secchi, and he estimated the star 7·5 magnitude on July 15th, 1868, and deep red; 7 magnitude, September, 1869. It was rated 6 magnitude by Webb on September 3rd, 1873, and 7·5 magnitude by Birmingham. Espin found it 7·3 magnitude on September 4th, 1882; 7·0 August 29th, 1883, and 7·1 on September 21st, 1883, and thinks it is "probably a variable of the 19 Piscium type."

7 Aquarii.—This star may possibly be variable. It was rated of the 3rd magnitude (!) by Ptolemy, 6 mag. by Al-Sufi (10th century), 5 by Argelander, and 6-5 by Heis. In Schjellerup's translation of Al-Sufi's Persian manuscript, its position is thus described:—"La 6e (7 Aquarii) est la suivante des trois étoiles situées dans la main gauche, et précède la 4e (β Aquarii) qui se trouve sur l'epaule gauche; elle est de la sixième grandeur, tandis que Ptolémée la dit de troisième, mais en vérité, elle est très obscure. La 7e (μ Aquarii) se trouve au milieu de ces trois étoiles et précède la 6e, s'inclinant vers le nord; elle est de petites de la cinquième grandeur; Ptolémée la dit de quatrième. Entre elle et la 6e il y a environ un empan. La 8e (ε Aquarii) est la précedénte des trois et des grandes de la quatrième grandeur; Ptolémée la dit de troisième." A glance at a star map will show that Al-Sufi's description is accurate, and proves that the star numbered 6 by Al-Sufi is identical with that numbered 7 by Flamsteed. Sir William Herschel found it less than μ but considerably brighter than 8 (Fl.) (Aquarii). It was rated 5·9 mag. by Gould, who suspects variation. It was measured 5·69 with the photometer at Harvard.

Sir William Herschel published in the *Philosophical Transactions* of the Royal Society for the years 1796, 1797, and 1799 a series of observations of the relative "lustre" of the stars in Flamsteed's Catalogue. In recently going through these interesting and valuable records of the comparative brightness of the stars at the close of the eighteenth century, and comparing Herschel's sequences with modern estimates and photometric measures, I have noticed a considerable number of suspicious cases. The following are perhaps the most remarkable and interesting.

With reference to the stars 30, 33, and 35 Arietis, Herschel gives the sequence 35, 30-33, which denotes that 35 was just perceptibly brighter than 30, and 30 a little brighter than 33. Herschel also gives 39, 35, 33. Now, according to the photometric measures made at Harvard, Oxford, and Potsdam, 33 is fainter than 35 but decidedly brighter than 30: 30 may therefore be variable. It is a double star—Struve I. 5—and the magnitudes of the components (which are 38·6″ apart) have been variously estimated by different observers. Struve gives them 6·1 and 7·1, or one magnitude difference, the fainter star *preceding* the other. Main found them equal in brightness in 1863; Dembowski rated them 5·4 and 6·6. Sadler thought there was not one magnitude difference in 1874, and Franks not more than half a magnitude in 1876. The photometric measures of the pair made at Oxford and Potsdam are discordant; those made at Oxford giving 6·33 and 6·78, or the *preceding* star the brighter, while the Potsdam measures gives 7·24 and 6·82, or the *preceding* star the fainter. This seems to show distinct variation, and the object should be further observed.

With reference to the stars in the Lynx, Herschel gives the sequence 22 — 21 — — 20, denoting that 22 Lyncis was a little brighter than 21, and 21 considerably brighter than 20. Now the photometric magnitudes of these stars measured at Harvard are 22 = 5·37 magnitude, 21 = 4·57, and 20 = 6·57, or 22 considerably *fainter* than 21. 21 was estimated 5th magnitude by Argelander and Heis, and 22, 6th magnitude. The *Durchmusterung* also makes 21 brighter than 22 — by 1½ magnitudes. Hence it appears that, if Herschel's sequence was correct (and most of his comparisons of relative brightness compare very favourably with modern measures), either 22 or 21 Lyncis is variable in light. These stars should be watched by variable star observers.

λ Geminorum.—In the notes to his catalogues Herschel says this star "seems to be increasing. There is an interval of nine months between the two observations of my catalogue. Mr. Bode supposes the star to be changeable." The Harvard measures make it very slightly brighter than δ Geminorum, while the Oxford and Potsdam measures make it slightly less. Both Argelander and Heis make λ perceptibly fainter than δ, and so does the *Durchmusterung*. The Potsdam measures vary between 3·5 and 4·1, and the star may possibly be variable to a small extent.

Herschel found ξ^2 (31) Geminorum only slightly brighter than ξ^1 (30), while Argelander, Heis, and the Harvard and Oxford measures agree in making ξ^2 about 1¼ magnitude brighter than ξ^1.

β and ζ Herculis.—Sir W. Herschel suspected both these stars to be variable. His observations make β sometimes distinctly brighter than ζ, and sometimes distinctly fainter. With reference to β he says, "By my observations the light of this star seems to be subject to change. Flamsteed's observations give it twice 3 m., and once 2 m." And with reference to ζ, he says, "From the expressions I have given of the brightness of this star, we have great reason to suppose it to be changeable." The Harvard and Potsdam measures make β slightly the brighter of the two, and so do Argelander and Heis.

SECRETS OF THE EARTH'S CRUST.

By Grenville A. J. Cole, m.r.i.a., f.g.s., *Professor of Geology in the Royal College of Science for Ireland.*

V.—THE GREAT EARTH-MILL.

THE movements of the solid ground have always excited considerable interest. The terrifying sensations imparted by ordinary earthquakes, the visible rents that in some cases remain after the shock has passed, the slipping of huge rock-masses which were already in a state of strain, conspire to impress whole populations with the instability of the crust beneath them. The earlier geologists were only too willing to magnify these effects, and to explain by tremors and shatterings all the prominent features of the globe. When strata of identical character appeared on opposite sides of a great valley, it was asserted that they had become separated by the abrupt opening of a fissure. The vast taluses on the slopes of mountains were said to be due to similar cataclysmic action; and, indeed, the rock-falls of the Rossberg and the Dobratsch gave a good deal of colour to the statement. The ocean basins were thought to be formed by the swift destruction of old continents, while the earthquake-rollers that occasionally flood the Pacific coast were regarded as a picture in little of the agency that brought our marine fossils in past times high upon the land.

The fact that the crust behaves at present in a far milder manner did not trouble these heroic authors. In those days, each successive fauna in the stratified series seemed to represent a new creation; the life of the globe had been every now and then swept away, to be remoulded and reproduced upon a nobler scale. Man happened to be living in a period of rest, specially provided for his needs. The next catastrophic movement would be, in all probability, his day of judgment and of doom.

The extreme uniformitarianism introduced by Hutton still allowed of recurrent catastrophes, whereby the worn-down land surfaces were somewhat swiftly elevated, and were brought up again to cope with the agents of denudation. Lyell,* however, treated the matter from the observational point of view, and concluded that the greater movements of the crust might have resulted from the cumulative effect of small ones. These small movements, he urged, were spread over long periods of time.

Since the publication of his "Principles of Geology," observations in every quarter of the globe have negatived the suggestion of world-wide, or even continental, catastrophes in the past. The recognised succession of living things is in itself incompatible with the violent rending of the crust. At the same time, certain epochs may be indicated in which the formation of mountains, and therefore, in all probability, of oceanic hollows, went on more rapidly than at others. While it would be rash to assume that the surface is now in any degree stable, it may be true that we enjoy a period of calm, following on the amazing earth-storm of later Miocene times.

Marked changes of level have occurred since man appeared upon the earth†; we may infer, then, that the crust is not truly at rest at the present time. The earthquakes from which certain regions suffer are interruptions in the general movement; and the volcanoes which are often associated with such areas are parallel manifestations of the same movement. The earth-pressure may even be in many cases responsible for the outflow of the lava.

Miners and geologists are familiar with "faults," or planes of fracture in the crust. On one side of the plane the rocks have been lowered; on the other they have been moved upward. The vertical amount of movement, the "throw" of the fault, may vary from an inch up to several thousand feet; and it varies in different parts of the same fault-plane, until at last the fracture dies away. If we take a sheet of paper and cut a slit in it with a knife, leaving the edges of the sheet intact, we can bend down the paper on one side of the slit to a considerable extent, without seriously deforming the whole sheet. Such a slit may illustrate how faults, which arise in the rock-sheet known as the earth's crust, may have a marked throw at one point and a diminished throw towards either end.

Such fractures, when viewed in a quarry-section, seem at first to appeal to the catastrophist. Here we find the rocks actually dragged asunder. A crushed "breccia," containing fragments of the rocks on either side, has been formed along the fault-plane, and testifies to the amount of force employed. Those who have wittily called faults "fossil earthquakes," have, indeed, ample justification; for the jar caused by the slipping of rocks along a fault-plane is, no doubt, the source of many a serious shock.* In several cases, as in the Japanese earthquake of 1891, a fault is made visible at the surface; but it is of course possible that a larger and concealed movement may have caused the earthquake, and may have allowed the surface-rocks to slip at the same time.

Yet the whole movement along a fault-plane is probably one of slow degrees. Repeated slips have produced an accumulative effect; and in some cases the final displacement must be regarded as differential, movements in opposite directions having occurred in different parts of the same fault-plane, and therefore possibly in the same part. The faulting is in reality so slow that some of the larger fractures are known to belong to more than one geological period. In the French Alps, M. Lory† has remarked the continuous deposition of sediments on the sinking side of a fault-plane, the movement continuing from the Oxfordian to the Senonian epoch. Similar movement probably accounts for the great thickness of the Old Red Sandstone, deposited, layer by layer, in central Scotland, in the floor of a lake bounded by fault-planes; and the modern history of Lake Tanganyika points also to continuous faulting along its margins. These slow movements form part of the work of what we may call "the great earth-mill," whereby the surface-rocks are shifted on one another, while those lower down may actually be ground to powder.

The breccia found along a plane of faulting is known as the "fault-rock." The fragments in it are grooved by friction with one another; the more yielding ones are squeezed out of shape, or are dragged out into mere wisps and films. In some places, a rough flow of the fractured solid may be observed, the more finely powdered material having moved round the larger blocks, which have thus become embedded in a groundwork, in the form of knots or "eyes."

The same features may be observed in certain yielding rocks, such as serpentines or limestones, on a broad and considerable scale. Earth-movements may cause these masses to be torn to pieces, and the faulting or "shearing" at any point is obscured by the quantity of fault-rock produced. The magnificent brecciated marbles of Italy,

* "Principles of Geology," Vol. I. (1830), p. 79.

† *See* "The Edge of a Continent," Knowledge, Vol. XX. (1897), p. 208.

* *See* the admirable discussion by Dr. Davison, in "The Hereford Earthquake of 1896" (Birmingham, 1899), p. 205.

† *See* De Lapparent "Traité de Géologie," 2me. éd., p. 1406.

which are often imitated in artificial forms, have thus originated in the great earth-mill. On a milder scale, but none the less convincing, we have the red Carboniferous marble of Cork in our own islands, which has assumed a sort of flow-structure during the overfolding of the district. Knots of the original fossiliferous rock are freely left in it, indicating the former structure of the mass.

Wherever, again, soft beds and brittle ones alternate in a stratified series, the less pliable beds tend to become broken up, while the yielding layers flow into their interstices. A false effect of fragmentation is thus produced, which is often intensified by the rounding of the included blocks. Such fragmental rocks of secondary origin have been styled "crush-conglomerates," and are of course nothing more than breccias in which flow has taken place.* The whole mass may be bounded at its margins by great fault-planes; but at the same time every block, and almost every layer, is faulted on a small scale against its neighbours.

Excellent examples of this form of brecciation may be seen where limestones and shales, in alternate beds, have become folded and compressed. Wherever a means of escape lay open, wherever the material could give way and flow, the shales have oozed out, and the limestones, which could not thus be elongated, have been at once broken into blocks. As the process goes on, these blocks become rounded until they resemble pebbles.† It is only here and there, by tracing the original bedding, that we are able mentally to reconstruct the series.

Such movements naturally have been noticed in rocks where true pebbles already exist. The Permian conglomerates of Worcestershire show many signs of the grinding of one hard pebble against the other, and the resulting striation, or "slickensiding," is so complete that it has been adduced as a proof of glacial action.‡ The quartzite pebbles, often two feet long, in the conglomerate of Cushendun, in Antrim, have been broken through again and again, the parts being faulted and then re-cemented at the contact. The limestone pebbles, again, of the "Nagelfluh" of northern Switzerland have actually been forced into one another, solution taking place at the same time, so that a large pebble may bear indentations from several of its neighbours, like the impress of a potter's thumb. Had the Alpine earth-movements continued, these massive Swiss conglomerates might have been reduced to crushed and unrecognisable calcareous shales.

If these things are done in the upper layers of the crust, and among rocks on the mere outskirts of a mountain range, we can form some conception of the changes that go on in the lower levels of the mill. The central axes of our mountains, moreover, where denudation has had full play, show us the crushed and crumpled rocks brought up by folding from below. In certain regions, again, such as Scandinavia and north-west Scotland, mountain ranges have been worn down to the roots, have been laid bare in horizontal section; and here we come into touch with some of the more intimate secrets of the crust.

Prof. Lapworth§ has recently dealt so clearly and succinctly with the whole question of metamorphic rocks, that one feels inclined to refer the reader at once to his historical and critical review. As a master in the work of unravelling metamorphic areas in the field, he perceives the difficulties of the student, and appreciates those cases which are susceptible of various explanations. Broad areas of gneiss occur, in which the foliation may be an original structure; the minerals in such cases, even while consolidating, may have been dragged out into lenticular forms by the flow of the viscid mass. But, in other cases, there are distinct signs of crushing; the flow is that of a brecciated material, and the knots and eyes represent those portions of the original mass that have escaped being ground to powder.

Prof. Lapworth has proposed the name "mylonite," from μυλών, a mill, for rocks in which the finer materials "have been sheared, dragged, and ground between the jaws of the gliding-planes."* The compact basis of such rocks is in truth composed of the flour of the great earth-mill. In microscopic sections cut from them, we see reproduced all the features that can be studied on a large scale in the neighbourhood of broken folds and faults. Matters are often complicated by the development of new crystalline materials along the planes of flow and foliation; but the conspicuous minerals in mylonites are commonly true residual eyes. In the example here chosen (Fig. 1), the gneissic structure is not readily apparent until polarised light is employed. Then the lumps of quartz and felspar are seen to be embedded in a fine rock-flour, which results from their abrasion. Whole flakes of quartz have been removed by shearing, and are accompanied, comet-like, by tails and streams of their own dust. The rock was originally a granite, almost free from mica; but it has begun to flow under earth-pressure, and its hardest minerals have been ground to powder along the shearing planes that traverse the whole mass.

By microscopic evidence, we are fairly able to discriminate between original and secondary flow. Quartzites, for instance, may be found, in which a flaky structure has been set up, and in which the larger grains are all lenticular. Such rocks, however, are not likely to have emerged as fluid lava from a caldron. The microscope shows how the lenticles are mere relics of larger granules, the opposite sides of which have been ground off, while a dust of quartz-fragments streams away along the planes of movement. Many grains are pulverised over all their surfaces, and we may conclude that others have disappeared altogether with the growth of the mylonitic ground.†

Rocks composed of more perishable or softer materials naturally suffer in still greater degree from the earth-mill. Gabbros go to pieces, the augites becoming dragged out as bands of brown-grey powder, and the basic felspars forming a compact and almost porcellanous ground.‡ In a great complex series of rocks, subjected throughout to pressure-metamorphism, it may often become impossible to recognise the character and relations of the original constituent masses.

We have passed from the inspection of fault-rock and breccias in the field to a consideration of rocks that may be regarded as regional breccias, and not as mere local accidents along planes of fracture. Down to their minutest structural details, these schists and gneisses bear witness to the great earth-mill. When we return from the laboratory to a review of their larger features, we see how one whole series of rocks may play the part of a

* *See* the full description by Mr. G. W. Lamplugh, "The Crush-Conglomerates of the Isle of Man," *Quart. Journ. Geol. Soc.*, Vol. LI. (1895), p. 563.

† Good illustrations of these processes are given in a paper by Messrs. Gardiner and Reynolds on "The Portraine Inlier," *Quart. Journ. Geol. Soc.*, Vol. LIII. (1897), pp. 528 and 532.

‡ *See* remarks by Mr. W. Wickham King, *Quart. Journ. Geol. Soc.*, Vol. LV. (1899), p. 128.

§ "An Intermediate Text-Book of Geology" (1899), pp. 113—145.

* *Op. cit.*, p. 144.

† *See* Sollas, "On the Structure and Origin of the Quartzite Rocks in the Neighbourhood of Dublin," *Sci. Proc. R. Dub. Soc.*, Vol. VII. (1892), p. 169.

‡ The rock of Penig, in Saxony, is a fine example.

groundmass to a more resisting series, the latter having been cut up into eyes some ten or twenty feet across. A granite may, for instance, be intersected by a number of basic dykes; when metamorphism sets in, that is, when one whole region of the crust begins to slide upon another, the granite flows again, tending to become finer in grain as its constituents yield beneath the pressure. The tough dark-coloured dykes become broken across, and huge lumps of them form eyes round which the new gneiss moves. At the same time, the margins of these eyes become foliated; augite breaks down into hornblende, streaked out by pressure into parallel layers. The extreme stage of such a complex mass gives us a regional gneiss of somewhat varying composition, here pale and granitoid, here dark with amphibole and biotite. These dark streaks, true foliation-layers in the gneiss, may be all that remains to us of the series of dykes that once broke through the granite.

Fig. 1.—Microscopic Section of Gneiss, with Mylonitic Structure in the more delicate bands. Loch Roag, Lewis, Outer Hebrides. × 12. Drawn under polarised light.

The mental reconstruction of a series such as this forms one of the most fascinating problems for a geologist in the open field. But we soon perceive that we must abandon any idea of measuring the "eyes" of one rock entangled in another by our pocket-rule, or even by our surveying-tape. As Lapworth has shown us in the Scotch Highlands, or as Suess has impressed upon us in describing his "horsts" of ancient rock,* whole districts may be regarded as knots round which other districts have been forced to break and flow. It is odd to look from our microscopic section to the map of Europe, and to trace in both the action of the great earth-mill. The waves of contorted rock, pent up against some pre-existing crystalline core, and broken against it in all the complexity of overfolds and regional faults—what are these but the features that mark a gigantic foliation in the crust? The massive breccias that occur along the thrust-planes appear as films of flowing mylonite. At one point, an "eye" provides attractions for the Alpine climber; at another, the yielding ground-mass has been seized on by the peasant for his fields.†

* *See* Knowledge, Vol. XXI., p. 27.

† Since the above was written, Dr. Maria M. Ogilvie (*Nature*, September 7th, 1899, p. 444), in the course of a remarkable paper on "Torsion-structure in the Alps," has called renewed attention to the dragging and flow that accompany large movements in the crust.

NOTES ON COMETS AND METEORS.

By W. F. Denning, F.R.A.S.

Swift's Comet (1899 I.) is now on the northern region of Libra, but has probably passed out of reach of the most powerful telescope in existence. It was accurately observed for position during about five months.

Tempel's Comet (1873 II.) will be too far south for observation in this country. On October 25th the comet will be situated about 1° north of the brilliant star Fomalhault in Piscis Australis.

Holmes's Comet (1892 III.)—This object is extremely faint and only perceptible in large instruments. No observations, except the one announcing its discovery by Perrine, appear to have been published in any of the scientific journals. An ephemeris by Zwiers (*Ast. Nach.* 3582) gives its position on October 3rd as R.A. 3h. 6m., Dec. 46° 56′ north.

No new comets have been discovered during the past few months; in fact, there appears to be a temporary dearth of conspicuous objects of this class. The dark autumnal sky will, however, probably reveal one or two comets visible in small instruments, and we await the definite announcement of their presence from those vigilant observers engaged in comet seeking.

The August Meteors (Perseids.)—Additional observations of this shower have now been received, and it appears highly probable that the maximum occurred on the night of August 11th, between 13h. and 14h., but the number of meteors counted proves the phenomenon to have been one of very moderate intensity. Mr. Ivo F. H. C. Gregg, of Malvern, found the horary rate for two observers as 70 between 13h. 30m. and 14h. 30m. On about August 9th, 10th, and 11th, a number of determinations of the place of the radiant point were made by various observers, and it appeared to be in the usual position. On earlier and later nights the centre of divergence accorded well with the easterly motion which it exhibited in previous years. M. E. M. Antoniadi at Juvisy, Mr. W. E. Besley at Clapham, S.W., Mr. J. H Bridger at Farnborough, and the writer at Bristol, noted this displacement of the radiant or very decided indications of it, and the observations as a whole corroborate it in a very distinct manner. It appears from a mean of the various positions that on August 1st the radiant was in $32° + 54°$, on August 10th in $44\frac{1}{4}° + 57\frac{3}{4}°$, and on August 14th in $50\frac{3}{4}° + 57\frac{1}{2}°$. One of the most brilliant of the Perseids seen during the recent display appeared on August 10th at 10h. 14m., and it was seen at Yeovil, Bridport, Bristol, Cardiff, and Shifnal, Salop. The meteor descended from a height of 76 to 40 miles from above Cheltenham to Bridgwater, and the length of its observed path was 54 miles.

Fireball of August 24th, 8h. 11m.—A splendid meteor was seen by a large number of persons in various parts of England. At places in Surrey the meteor passed through Perseus and disappeared just under Capella. At Meltham, Yorks., Mr. C. L. Brook estimated the meteor as one-sixth as bright as the moon, and gave the path as from $352° + 13\frac{1}{2}°$ to $2° + 12\frac{1}{2}°$. At Liverpool, Mr. C. Jefferies noted that it passed from the centre of Pegasus to between α Andromedæ and 7 Pegasi, and thence into Pisces. He describes it as like a spear with shaft and head complete. A correspondent at Chester writes that he saw a brilliant meteor flying earthwards in N.E., and that shortly afterwards he perceived a strong odour of sulphur. Two observers near Leicester say they saw a ball of fire, which, crossing the road in front of them, fell into an adjoining field. It was quite low down, and did not appear more than one hundred yards away from them. Another writer, at Weaste, near Manchester, says that the meteor resembled a ball of fire of most dazzling brilliancy, and from which long fangs of fire were cast off during its transit. It disappeared suddenly when apparently about two hundred yards from the earth. For several days the newspapers contained a considerable number of letters on this phenomenon. The real path of the meteor was over the North Sea, and it appears to have fallen from a height of seventy-seven to twenty-seven miles. The length of its course was one hundred and eighteen miles, and its radiant point at $345° + 14°$, close to the bright star α Pegasi.

Fireball of August 27th, 10h. 13m.—This was an exceptionally fine object, though it does not appear to have been so generally observed as the one previously described. It appeared in the

northern sky from the south of England, and took a long horizontal course from about north-west to north-east. Lieut.-Col. Boileau, of Trowbridge, describes the path as directed from Ursa Major, afterwards passing above Capella and through Perseus towards Algol. Mr. J. L. Whittle, of Manchester, estimated that the meteor was half as bright as the moon, and describes its course as from Deneb Cygni to Aquarius. It was also seen at Oswestry, Birmingham, Bristol, &c., but the observations are not sufficiently exact to indicate the radiant accurately. This point was situated in Ursa Major, and further descriptions of the visible path of this fine meteor would be very valuable in aiding to fix the position definitely.

Other large meteors.—The following have recently been recorded:—

Date.	Time. h. m.	Mag.	α °	δ °	α °	δ °	
August 27 ...	9 15	♀	216	+38½	to 201½	+32½	Slow. W. E. Besley, London, S.W.
,, 28 ...	9 30	♃	302½	+13½	to 315½	− 5	Slow. Train. W. E. Besley, London, S.W.
,, 28 ...	12 35	Full ☽	292½	+17	to 301	+ 3	Slow. Train. W. E. Besley, London, S.W.
Sept. 2 ...	12 4	3×♀	40	+67	to 37	+74	Swift. Streak. W. F. D., Bristol.
,, 4 ...	8 13	♀	220	+35	to 217	+25	Slow. A. S. Williams, Hove.
,, 4 ...	8 14	♃	297	+28	to 296	+13	Swift. Streak. T. H. Astbury, Wallingford.
,, 8 ...	8 21	>♀	313	+ 4	to 287	+ 4	Slow. Train. T. H. Astbury, Wallingford.

The last of these meteors was also seen by Mr. A. King, of Leicester. It belonged to a radiant at 347°+3°, and appeared over the English Channel and south of England, descending from seventy-one to twenty-six miles during a visible flight of one hundred and fourteen miles.

Additional observations of these objects would be very useful.

In October the Orionid meteoric shower will form the principal display. The moon will be full, however, at the time of the maximum (about October 18th to 20th), but the early part of the shower, on October 12th to 15th, may be well observed if clear weather prevails.

Microscopy.

By John H. Cooke, F.L.S., F.G.S.

The addition of a little ammonia to the water in which diatomaceous materials are being washed facilitates the removal of slimy, gelatinous products, cleanses the diatoms, and hastens their settlement to the bottom of the vessel.

To extract siliceous organisms from rock fragments, heat the rock to about one hundred degrees Fahrenheit, and then plunge it into a boiling solution of soda sulphate. This salt takes up water as it crystallizes, and the rock, therefore, readily pulverizes under its influence.

Balsam of tolu, from which the cinnamic and benzoic acids have been removed by prolonged boiling in a large quantity of water, is an admirable mountant for diatoms. It should be dissolved in rectified benzine, filtered, dried, and finally dissolved in alcohol or chloroform. The refractive index of the balsam thus prepared is 1·72 when dry.

Methyl-green is an effective double stain for all vegetable sections. When applied to fibres, whether of pure cellulose or of lignin, it produces a deep green if the fibre has been mordanted before staining; while a light green is produced when the order of stain and mordant is reversed. Apply in a strong aqueous solution.

For the preparation of permanent mounts of living amæboid organisms, the following method, first suggested by Certes, will be found to give satisfactory results. To thirty cubic centimètres of the water containing the living amœbæ, add about one cubic centimètre of osmic acid solution (one per cent.). After settling for a few hours wash the deposit, concentrate, stain, and mount in distilled water containing a trace of osmic acid.

To demonstrate in yeast cultures the formation of alcohol as a result of the growth of the plant in a sugar solution, Mr. A. L. Treadwell suggests the following method as being less troublesome than the ordinary qualitative tests, and much more satisfactory. To the yeast culture add a few drops of iodine solution, and then enough KHO solution to destroy the colour of the iodine. Iodoform will be produced and can be recognized by its characteristic odour.

The proper preservation of soft-bodied organisms is one of the chief difficulties that the working microscopist has to contend against. The number of preserving media is great, but there are few of them that are at once as simple and effective as that suggested by A. E. Verrill for preserving insects in their natural forms and colours. The solution consists of two-and-a-half pounds of common salt and four ounces of nitre dissolved in a gallon of water and filtered. The specimens should be prepared for permanent preservation in this solution by being previously immersed in a solution consisting of a quart of the first solution and two ounces of arsenite of potash in a gallon of water.

To kill sponges extended, Mr. W. R. Melby proceeds thus: The specimen is placed in a glass jar filled with water, and the following solution is added drop by drop at intervals of one minute:—Methyl alcohol, ten parts; salt water, ninety parts; natrium chloride, six-tenths of a part. If the specimen does not retract after forty-five minutes, pour some hot sublimate on quickly. To preserve specimens for sections, put them in one per cent. osmic acid for two minutes and then successively in five, ten, twenty, thirty per cent. alcohol up to ninety per cent., harden in absolute alcohol and imbed in paraffin, stain with borax carmine and hæmatoxylin.

The distribution of aquatic life from season to season throughout the various zones of the plankton in the larger masses of water of the globe is an object of study which has received considerable attention at the hands of investigators during the last decade. The greatest difficulty that has been experienced has been the need of an apparatus upon which the operator can rely to work satisfactorily under all conditions and at all times of the year. The nets that are usually used cannot claim these advantages, inasmuch as they are always liable to damage and loss when working on a rocky bottom, and during the winter months, when the plankton yields its most interesting results they are inadmissible in northern latitudes owing to floating ice. The accuracy of the results, too, leave much to be desired, as with the net it is not possible to determine exactly the volume of organisms actually present in a given quantity of water, nor is it practicable to determine the various groups that are characteristic of the many vertical zones or strata of water of which the plankton is constituted.

For critical work, nets have had to be discarded, and in place of them Dr. H. B. Ward has used, during his recent investigations on the Great Lakes, a light weight force pump which he calls the "plankton" pump, and which can be carried about and operated by one person. The cylinder of the machine is eleven inches long by three and a half inches diameter, and it has a capacity of three hundred and forty-seven and a half cubic inches per stroke. It is essentially an ordinary force pump, save that it has very finely ground check valves, to which, it is believed, the accuracy of the working of the apparatus is largely due. The pump is connected with the water by a hose one and a half inches in diameter, the lower end of which is adjusted to the various vertical zones of water by means of an attachment to a floating block. Most gratifying results have attended the use of this apparatus. It is possible to measure with great accuracy the amount of water filtered. Collecting can be carried on without any disturbance of the water, and water can be drawn from any stratum, thus enabling the investigator to examine in detail the vertical distribution of the plankton.

Dr. H. A. Hagen has made careful records for the purpose of determining the durability of the rubber stoppers which are used in vials containing microscopic objects in alcohol. From an examination of some seven thousand vials with rubber stoppers, two-thirds of which had been in use for from ten to twelve years, he comes to the conclusion that less than one in a thousand gives out every year after twelve years' use, and in the first six years probably only one out of two thousand. Stoppers of large size keep much longer than those of small size. American rubber stoppers are all made of vulcanized indiarubber, and have the disadvantage of forming small crystals of sulphur about the stopper, which become loosened and attach themselves to the specimens. It is supposed that pure rubber stoppers used for chemical purposes would not present this disadvantage, which may be obviated, however, or very much reduced, if the stoppers are washed or soaked in hot water for an hour or two before being used.

The usual processes that are adopted for the hardening of brain and similarly soft tissues, frequently result in failure by reason of the pressure of the tissues on the hard surface of the containing vessel, and the consequent mis-shapening of the lobes and convolutions, or the rupturing of the delicate superficial membranes. To prevent this, Prof. W. C. Krauss, of Nebraska University, has devised a hardening receptacle which obviates most of the disadvantages of the old method besides being exceedingly simple and inexpensive. An oval tin pail, of from four to six quarts capacity, with an ordinary handle and a tight fitting cover, has a series of about ten hooks soldered on the inside about one inch from the top of the rim. The convex surface of the fresh brain is covered with a sheet of cotton, and over this is placed a piece of netting. The whole is then lowered gently into the pail containing the hardening fluid, and suspended in it by means of the hooks. The brain thus undergoes hardening in all directions at once, and does not lose its normal symmetry. The cotton protects the convolutions from being ruptured.

Many workers have in their battery of objectives samples of both the achromatic and apochromatic types, having their favourites of both series. But this has necessitated two sets of eye-pieces, the Huyghenian for the former, and the Compensating for the latter; but this will no longer be necessary, because in the "Holoscopic" eye-piece of W. Watson & Sons we have an eye-piece which has been specially devised for both purposes. It consists of two tubes, the outer one carrying the field lens, and the inner, or telescopic one, having fixed to it the eye lens and diaphragm. Carefully selected appropriate glasses are used for the lenses, and when the telescopic tube is pushed in as far as it will go, the eye-piece is an under-corrected one, suitable for work with achromatic objectives. As the tube is drawn out, the eye-piece becomes increasingly a compensating one, possessing the so-called over-correction associated with the compensating eye-pieces which are used with the apochromatic objectives. This eye-piece yields really beautiful images, and not only does it obviate the necessity for two sets of eye-pieces, but it gives to the worker a power of adaptation which he has not hitherto possessed. Very few of the apochromatic objectives have the same amount of under-correction, consequently with the fixed eye-pieces the over-correction is frequently too great. With the "Holoscopic" eye-piece, the over-correction can be exactly adjusted to the objective, and a divided scale is engraved upon the draw-tube, so that the position may be recorded. It is made in the following magnifying powers:—

For the six-inch tube length, 5, 7, 10, and 14 diameters.
For the ten-inch tube length, 7, 10, 14, and 20 ,,

The cost is very little greater than that of the Huyghenian eye-pieces.

THE FACE OF THE SKY FOR OCTOBER.

By A. Fowler, F.R.A.S.

The Sun.—On the **1st** the Sun rises at 6.2, and sets at 5.38; on the **31st** he rises at 6.54, and sets at 4.34. Sunspots are not likely to be either numerous or conspicuous.

The Moon.—The Moon will be new on the **4th**, at 7.14 P.M.; enter first quarter on the **12th**, at 6.10 A.M.; will be full on the **18th**, at 10.5 P.M.; and enter last quarter on the **26th**, at 9.40 A.M. The following occultations are the most interesting during the month:—

Date.	Name.	Magnitude.	Disappearance.	Angle from N.	Angle from V.	Reappearance.	Angle from N.	Angle from V.
Oct. 10	4 Sagittarii	4·6	7.3 P.M.	93°	74°	8.10 P.M.	242°	211°
,, 16	19 Piscium	5·2	11.53 P.M.	52	30	13.0	251	221
,, 21	κ^1 Tauri	5·5	8.37 P.M.	76	118	9.35 P.M.	261	303

The Planets.—Mercury is in superior conjunction with the Sun at 4 A.M. on the **1st**, and will, therefore, be an evening star throughout the month. He is, however, unfavourably placed for observation on account of nearness to the Sun and southerly declination.

Venus has now become an evening star, but is still too near the Sun for observation. On the **26th**, at 6 p.m., she will be in conjunction with α Libræ, the star being 0° 6′ S., but both star and planet will have set nearly an hour before this event.

Mars and Jupiter are both evening stars, but are too near the Sun for useful observation. They will be in conjunction with each other on the **11th** at 5 P.M., Mars being 1° 11′ S., and both being very near to α Libræ: the planets, however, will set about three-quarters of an hour after the Sun, so the conjunction can hardly be considered observable.

Saturn remains in the southern part of Ophiuchus, and may be observed in the early evening, low down in the south-west, under favourable conditions. Near the middle of the month he sets about 7.40 P.M. The rings are widely open.

Uranus is not observable.

Neptune, in Taurus, may be observed by those prepared to take the trouble to identify it. He rises about 8 P.M., and is situated in the Milky Way, nearly midway between ζ Tauri and η Geminorum.

The Stars.—About 9 P.M. at the middle of the month, Auriga and Perseus will be in the north-east; Taurus low down in the east; Aries, Pisces, and Cetus in the south-east; Andromeda and Cassiopeia high up and a little south of east; Pegasus and Aquarius in the south; Cygnus high up to the south-west; Aquila, lower; Lyra and Hercules towards the west; Corona towards the north-west; and Ursa Major in the north.

Convenient minimum of Algol occur on the **7th** at 10.18 P.M., on the **10th** at 7.7 P.M., and on the **30th** at 8.50 P.M. It will be interesting, too, to watch Mira Ceti, which should be at or near a maximum about this time.

Chess Column.

By C. D. Locock, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of September Problems.

No. 1.

(By H. Bristow.)

1. R to Q2, and mates next move.

No. 2.

(By P. G. L. F.)

Key Move—1. K to B5.

If 1. . . . Kt moves. 2. Kt to Kt6ch, etc.
1. . . . P to Q6. 2. Q to R4ch, etc.
1. . . . B moves. 2. Q to R6ch, etc.

Correct Solutions of both problems received from A. H. Doubleday, Alpha, J. Baddeley, N. M. Munro, G. C. (Teddington), W. W. S., J. E. Lelliott, W. de P. Crousaz, G. D. Crowther, Capt. Forde, H. Le Jeune.

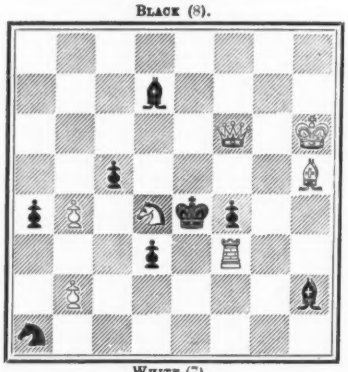
Of No. 1 only, from A. J. Head.

Mexfield.—The work referred to is not published.

XUM

PROBLEM.

Black (8).



White (7).

White mates in four moves.

[The above is a competing problem in the current tourney of the *British Chess Magazine*. In spite of its difficulty it will well repay the trouble of solving, a trouble which we hope some of our solvers will not grudge.]

CHESS INTELLIGENCE.

Mr. H. E. Atkins won the first prize in the Amsterdam Amateur Tournament without losing or drawing a single game. This is undoubtedly a very fine performance, even though the majority of the sixteen competitors were not quite of the front rank. Mr. Atkins also won the Brilliancy Prize; the game which obtained it will be found below.

Another celebrated chess player and theorist has passed away. Baron von Heydebrandt und der Lasa died on July 27th, at the age of eighty years. He was one of the very finest players of his time, and the original author of the "German Handbuch."

The appended game obtained the Brilliancy Prize in the recent amateur tournament held at Amsterdam :—

"Ruy Lopez."

White. (J. D. Tresling.)	Black. (H. E. Atkins.)
1. P to K4	1. P to K4
2. Kt to KB3	2. Kt to QB3
3. B to Kt5	3. Kt to B3
4. Castles.	4. P to Q3
5. Kt to B3 (*a*)	5. B to K2 (*b*)
6. P to Q4	6. Kt to Q2
7. Kt to Q5	7. Castles
8. Kt × Bch	8. Q × Kt
9. P to Q5	9. Kt to Q1
10. B to Q3	10. K to R1
11. Kt to K1	11. P to KB3
12. P to QB4 (*c*)	12. Kt to B2
13. B to K3	13. KR to Kt1
14. R to B1	14. P to KKt3
15. R to B3 (*d*)	15. Kt to B4
16. B to B2	16. P to B4
17. P to B3 (*e*)	17. P to B5
18. B to B2	18. P to KKt4
19. P to KKt4	19. Kt to Q2
20. R to R3 (*f*)	20. Kt to B3
21. K to Kt2	21. P to KR4
22. P to R3	22. K to Kt2
23. R to R1	23. R to R1
24. P to Kt4	24. Kt to R3
25. P to B5	25. B to Q2
26. Q to B1 (*g*)	26. K to Kt3
27. BP × P	27. BP × P
28. B × RP (*h*)	28. P × P
29. RP × P	29. Kt (R3) × P (*i*)
30. B to KKt1 (*j*)	30. R × R
31. K × R	31. Q to R2ch
32. K to Kt2	32. Q to R6ch
33. K × Q	33. Kt to K6 dis ch
34. K to R2	34. R to KR1 mates

(*a*) I prefer 5. B × Ktch, and 6. P to Q4.

(*b*) Not usually a good square for the Bishop in the close forms of the Ruy Lopez. 5. . . P to KKt3 might be played.

(*c*) As the result of Black's dilatory manœuvring, White should here get some attack by 12. P to KB4, and P to B5 if the Pawn be not taken.

(*d*) Perhaps 15. B to Ktsq is better. Then if 15. . . . Kt to B4, 16. P to QKt4; as it is, Black gets time to advance his KBP and free his game considerably.

(*e*) 17. P × P would give him a freer game, with prospects of playing the Q to R5 in the near future. Black's open Knights' file would not be particularly formidable.

(*f*) This is useless, as he cannot conveniently take the RP. 20. P to QKt4 is probably his best move.

(*g*) To defend the Rook, with a view to B × RP; but the manœuvre is too slow. P × P at once would be better.

(*h*) Overlooking Mr. Atkins' not very hidden sacrifice.

(*i*) Correct on principle. Two such Pawns alone are worth the Knight, apart from the attack which would inevitably follow its capture.

(*j*) If 30. Kt to Q3, R × R, 31. Q × R, R × B, etc. His best chance lies in 30. R × R, R × R; 31. P × Kt. The actual finish is pretty and problematic, though not unobvious. Mr. Atkins played the final attack with skill, after a somewhat cramped opening development.

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